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THE WORLD IS ITS FIELD

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THE REPUBLIC OF COLOMBIA AND THE PANAMA CANAL.

By John Geo. Leigh.

As these sheets are printed, the reports from Bogotá are conflicting, but for the greater part unfavourable—some of them apparently maliciously biassed. The immediate trend of the negociations is highly uncertain. But we hold to our faith that the project will ultimately be brought to a triumphantly successful completion, by virtue of its own inherent right to survive through its superior merit. The economic and engineering advantages of the Panama Canal line are so great that it must be acquired for the world's commerce, and the present barriers will fall, as others have fallen, before the insistent progress of the demand for "the best." Mr. Leigh's article is interesting in giving an idea of the country as a whole, outside of the canal zone of which so much has been heard.—THE EDITORS.

IT is easy to over-estimate the importance, actual and contingent, of the latest phase of Isthmian Canal negociations. Hasty conclusions, based upon partial and not always reliable information, or influenced by individual prejudices or morbid deference to what promises to be the more popular view, are part of the price we are sometimes asked to pay for the services of a luxuriant, enterprising, and encyclopædic press. George Washington, speaking of periodical publications in the year 1788, is said to have described "such easy vehicles of knowledge" as " more happily calculated than any other to preserve the liberty, stimulate the industry, and meliorate the morals of a free and enlightened people." All this is probably as true at the beginning of the twentieth century as it was at the end of the eighteenth. Nevertheless, it is a quite open question whether the influence of our great newspapers today is not more closely associated with dexterous use of modern resources for the annihilation of time and dis-

tance than with whole-hearted desire for the right guidance of popular opinion.

No sooner was it announced that the Colombian Senate had rejected the canal treaty, signed at Washington on January 23rd last by Mr. John Hay and Señor Herran, as official representatives of their respective countries, than the majority of newspapers in England, and some, at least, in the United States, gravely assured their readers that "Now we have heard the last of Panama." This phrase is evidently much-esteemed in the office of a certain London journal, for it loomed large in editorial comments not only upon recent news from Bogotá, but also, early in 1902, in relation to the remarkable vote of the United States House of Representatives in endorsement of Mr. Hepburn's Nicaragua canal bill; and I doubt not that an investigation of the file would be rewarded with frequent disclosures of the same, or equivalent, words applied to other untoward incidents in the history of the Panama undertaking. Pretty much the same kind of story might probably

A SQUARE IN BOGOTÁ.

CARTAGENA—A SEAPORT AND RAILWAY TERMINUS IN THE PROVINCE OF BOLIVAR.

be told of not a few American periodicals, which, "raised" on the idea that the Nicaragua route was practically synonymous with the expression "Isthmian Canal," are still loath to recognise, as a serious factor, the existence of a formidable competitor. It is a shrewd business maxim that if any statement is printed often enough, the public in the end will most certainly believe it. The death and burial of the Panama project have been so frequently enlarged upon that it is small wonder there are many people convinced of their actual occurrence.

It may be quite freely admitted that the rejection of the treaty by the Colombian Senate is an annoying rebuff to the Administration of the United States, and a matter for sincere regret to all well-wishers of the speediest completion of a navigable highway between the Atlantic and Pacific oceans, calculated to be of service to the commerce of the world. But it by no means implies that there is an end of the question, that the only solutions of the difficulty which has been created are either to ignore the Government at Bogotá, or, with the best grace possible, fall back upon the Nicaragua-Costa Rica route. These are counsels of despair, unbecoming a great people not altogether innocent

of blame in the matter. The situation is one which calls for dispassionate and careful consideration, and as a first step to this we should frankly ask ourselves whether adequate pains have been taken towards honest study of Colombian sentiment. The latter may be all that it is represented to be—sordid, bombastic and the like; but it is not enough to say so, even though the statement be the reflex of conviction. To

TYPICAL STREET SCENE IN A COLOMBIAN CITY.

all questions there are two sides, and it is worthy of note that even now, after the lapse of many weeks, we cannot be said to know precisely the reasons which actuated the hostile vote.

Much has been made of the circumstance that the treaty conflicted with the Constitution of Colombia, inasmuch as it involved the renunciation of certain sovereign rights—of civil jurisdiction, of police, and of criminal jurisdiction over foreigners—in the zone of territory through which the canal is to pass. The Colombian Constitution, we are told, expressly forbids any alienation of territory, and we are asked to believe that the instrument is so sacrosanct in the eyes of Colombians that not even for millions of dollars and other material advantages would Congress or the people permit it to be tampered with. In Spanish America, politicians are lawyers when they are not soldiers; though prone to illegal acts in practice, they never hesitate to in-

voke, as matter of theory, the strictest letter of the law, and nothing delights them more than opportunity to air their patriotism for the benefit of the foreigner and pompously express the most elevated of sentiments. These amiable characteristics have resulted, in the case of Colombia, in no fewer than seven Constitutions, three changes in the very title of the Republic, and local and general "revolutions" so frequent that even the best informed historians of the country find it difficult to enumerate them in correct chronological order. The best test of the value of Senatorial speeches concerning the sanctity of the Constitution will be found in the fact that the rejection of the Hay-Herran treaty was promptly followed by the introduction of a measure providing for constitutional amendments likely to smooth the way for further negociations.

Another explanation offered by Colombian diplomatists is that the construction of a Panama canal by a foreign government will virtually

HONDA, ON THE UPPER MAGDALENA RIVER, STATE OF TOLIMA.

destroy its international character and its neutrality as a highway open to all nations in times of war as well as peace. They point out that this was one of the main conditions of the concessions granted to the French companies, and unctuously dilate upon Colombia's appreciation of its duties to mankind, as evidenced by its unselfish championship of the

A CUSTOM OF THE COUNTRY.

original aim of the canal. Evidently the Colombians have read more carefully or been more impressed by the utterances of certain United States newspapers and politicians before and after the ratification of the second Hay-Pauncefote convention, than by the terms of that instrument or the oft-repeated official declaration that the "fixed policy" of the United States in regard to any isthmian canal is its dedication to "the common use of all nations, on the most liberal terms and a footing of perfect equality for all."

According to a semi-official statement issued for the delectation of English readers, "the Colombian people abhor the idea of the dismemberment of their fatherland." "Swayed by the ideal of the integrity of its territory," the Republic has shown itself "untainted by mercenary motives," and consequently "deserves the sympathy of the whole world." It is, we are told, the transgression of fundamental principles, combined with greediness of gain, which breaks up national union and concord; and all persons tempted to doubt that ardent, self-sacrificing devotion to political ideals is, and has ever been, the common attribute of Colombians are dismissed from further notice as saturated with that "baneful commercialism whose highest aim is the accumulation of wealth." This, presumably, is "pretty Fanny's way" of conveying the information that dread of American "expansion" dictated the rejection of the treaty.

The arguments which figure so prominently in the Colombian statement of the case, and each of which, we are assured, "sufficiently justifies" the action of the Bogotá notables, do not by any means exhaust the list of possible explanations. The opponents of the treaty made considerable play with quotations from speeches delivered in the

United States Senate during the not always edifying debates which preceded the passing of the Spooner bill and the ratification of the Hay-Herran convention; and it must be confessed that the *Congressional Record* reports many statements and threats eminently calculated to provoke apprehension and deeply wound Colombian susceptibilities. Moreover, it is far from certain that anti-American prejudice was not sensibly strengthened by the use made of these speeches, and other more potent arguments, by citizens of the United States, less recognizant of the national needs than of individual and vested interests. These are upleasant considerations, upon which I am reluctant to dwell, but they require to be borne in mind when—as I hope may be shortly the case—satisfactory means are devised to overcome existing difficulties.

There is one point bearing upon Colombian opposition to the canal, quite irrespective of the terms of the Hay-Herran convention, which, in my opinion, has been too long ignored. To the outside world, other than persons who have lived or travelled in the Republic, the topography of the country has seemed a matter of no significance. In reality, it plays a very important part in the councils of Colombia, and should serve as a forcible illustration of the fact that political boundaries are frequently less important than geographical actualities. Thanks to its unique position in relation to the commerce of the world and the 47 miles of railway which links its two seaboards, the "State" of Panama is far better known to most foreigners than the mainland of the Republic. This is matter for regret, for, as regards climate, natural wealth, and beauty, it cannot be compared with any one of the other eight constituent departments with which it is politically united. It is the spoilt child of the Republic, a cause of constant anxiety and expense, yet invariably humoured and de-

THE COLOMBIAN LOAFER.

ferred to. Every Colombian believes that the isthmus is the most coveted spot in the world, and that, if retained as part of the Republic, it will, some time or other, prove a source of incalculable wealth. The people of the department are fully alive to the advantages which they may claim as the result of this appreciation, and consequently seek to exercise, whenever it may suit their humour, the remarkable powers enjoyed under the Constitution of 1861-85, which denied to the federal government the right

ON THE LINE OF THE PANAMA RAILWAY.

to interfere in the affairs of the constituents States, even for the punishment of crime or the preservation of public order—indeed, expressly provided that "when one State of the Union shall be at war with another, or the citizens of any one State shall be at war amongst themselves, the Government of the Union is required to preserve the strictest neutrality." While such conditions prevailed *de jure,* the original canal concessions were granted; and it has ever been a very sore point with the most active spirits holding the reins of government in the isthmus, or aspiring to do so, that so much, or, indeed, any share, of the "boodle" derived from the sale and prolongation of concessions found its way into the treasury at Bogotá. These and other circumstances duly considered, it will be readily understood that the proposed

IN THE MARKET.

payment by the United States of such a large sum as that offered in the rejected treaty has caused considerable heart-burning throughout the Republic. It is not so much a question of amount, as its division and the *personnel* of the parties likely to be in power when the money is paid, which disturb Colombian equanimity.

The people of the department of Panama are undoubtedly united in desiring the completion of the canal, and, so far as unanimity is possible where financial considerations intervene, they may be said to favour the ratification of the treaty with America. The same is true, with less reservation, of the commercial classes throughout the Republic, who recognise in the canal and the legitimate exercise of American influence certain to follow a solution of present difficulties, guarantees for the development of the country and more orderly and honest government. Unfortunately for Colombia and the world's progress, these

COLOMBIAN GAMINS.

THE PILON—OR NATIVE PESTLE AND MORTAR.

KITCHEN OF A COLOMBIAN HOUSE.

enlightened views are not shared by a majority of the ruling, or even educated, classes. Under shelter of the specious arguments that no port on the isthmus leads to any part of the mainland of the Republic and that even the department of Panama may suffer injury owing to the degradation of its two chief towns from the position of steamship termini, not a few intelligent Colombians contend that their country will derive no economic advantages from the completion of the Isthmian Canal. Repeated experience elsewhere in the development of transport facilities has proved how absolutely fallacious are argu-

THE STOCKS.

ments of this kind, but the Colombians cannot be very severely blamed for expressing confidence in them when even such shrewd business men as the managers of the United States transcontinental railways set an example. That the Colombians are not absolutely convinced upon the point is shewn by the fact that they are willing to forego all their objections to the scheme if the Administration and people of the United States will agree to bear the entire cost and hand over to the South American Republic, as full partner, a permanent interest in the enterprise.

The Isthmian Canal is destined to be one of the most remarkable triumphs of modern engineering science applied to the annihilation of

time and distance. By the strange irony of fate, however, it will pass through portion of a country more deficient in means of communication than any other settled and pseudo-civilised territory throughout the world. In the department of Panama are three open seaports, the two railway terminals, and Bocas del Toro, the centre of a large banana industry, to the north of Colon. Excepting the railway, it cannot be said to have advanced far in the development of internal communication since the early years of the Spanish occupation; indeed, in some measure, progress has been backward, for not a few of the paved roads built by the Spaniards in the first half of the sixteenth century are now overgrown and impassable. The isthmus, however, as compared

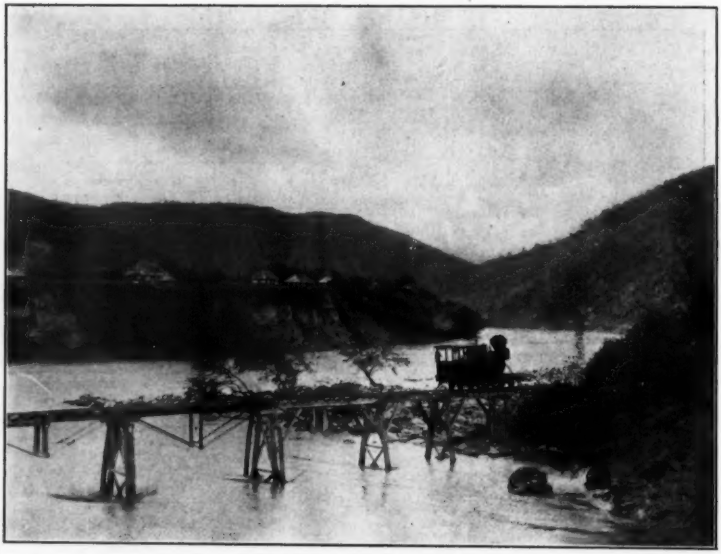
CACTUS AND FOREST JUNGLE.

with the mainland of Colombia, is a small country and a mere waste of forest and swamps. Yet, in the other eight departments, some teeming with mineral wealth, others blessed with fine pasture lands and rich soil capable of producing unlimited quantities of coffee, cacao, sugar and tobacco, there are little more than 300 miles of constructed railway and, outside the towns, not a dozen miles of decent road. In the interior, away from the railways and great navigable rivers, transportation is by pack mules and porters, travelling over bridle paths, just

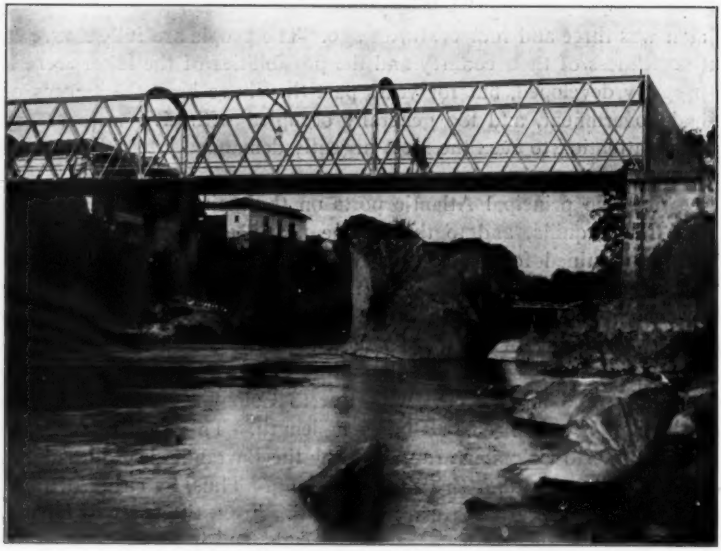
ON THE MAGDALENA RIVER.

as it was three and four centuries ago. The people are fully aware of the richness of their country and the possibilities of the latter were it properly developed, but for years past they have been the victims of bad government, and too generally occupied with civil wars to pay much attention to even the most urgently demanded internal improvements.

The two principal Atlantic ports on the mainland are Cartagena and Barranquilla, and to them come nearly all the passengers and freight destined for the interior via the river Magdalena, the main artery of Colombia's internal commerce. From Cartagena runs a line of railway, 66 miles in length, the property of an American corporation, to the port of Calamar, situated on the Magdalena. Barranquilla, which is also on the Magdalena, lies at a short distance from the coast, and is connected with Puerto Colombia, better known as Sabanilla, by a railroad 28 miles in length. This railroad and the pier at Puerto Colombia are worked by the Barranquilla Railroad and Pier Company, Ltd., a British undertaking. Thus, by either of these two lines, the Magdalena can be reached. From the coast to Honda, where the so-called Lower Magdalena ends, and the mule road to the capital begins, lies a stretch of river about 600 miles in length, which



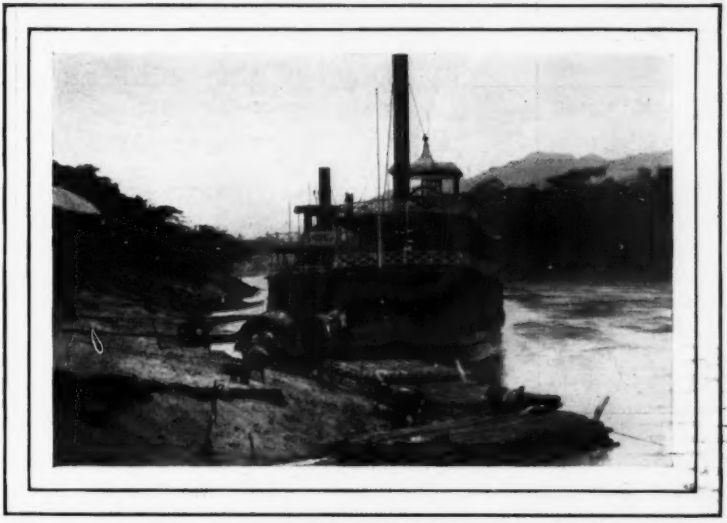
RAILWAY BRIDGE, HONDA.



A RUINED BRIDGE AND ITS MODERN SUCCESSOR.

is operated mainly by two companies, Colombian and American. In normal times, the river steamers accomplish the distance between Barranquilla and Honda in six to seven days for the up, and four days for the down journey; but not infrequently, during periods of civil commotion, the passage from the coast has occupied from three to four weeks.

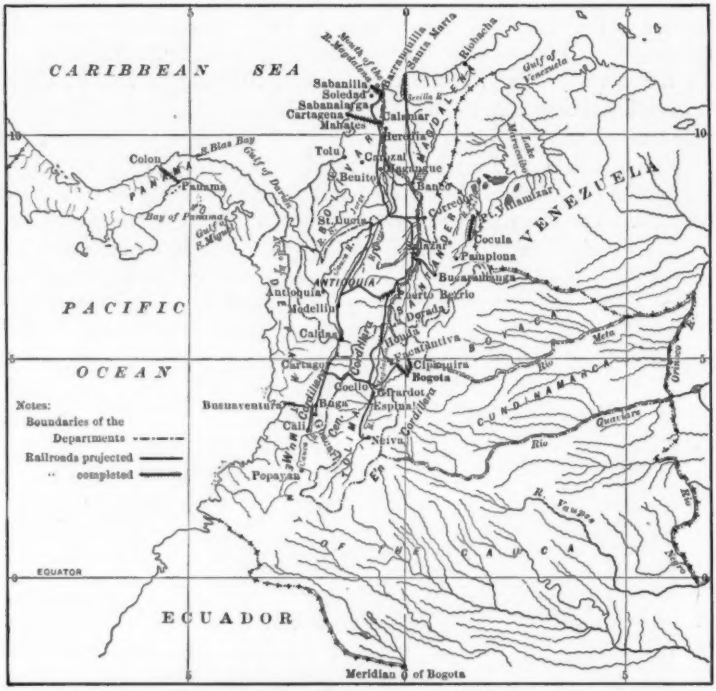
From Honda to Bogota there remains a mule journey of three days, over a track which, in comparison with the average Colombian "road," may be described as easy. As a matter of fact, it offers, during the best of times, very serious impediments to the transport of mer-



RIVER STEAMERS.

chandise, and, when the country is disturbed, is usually infested by bands of guerillas. The expense, also, is considerable, for the cost of carrying a mule load from Honda to the capital rose from 25 pesos (equivalent to £1, at 500 per cent. exchange) before the outbreak of the last war, to 4,000 pesos Colombian currency (at exchange of 5,000 per cent. equivalent to £1 12s.) during the progress of the struggle. Since the declaration of peace, the demands of the muleteers have somewhat abated, but throughout the country transport charges of every kind are considerable higher than was the case a few years ago.

Another railway touching the Atlantic coast is that which runs from Santa Marta to the Sevilla river, a distance of 46 miles. This



MAP OF THE REPUBLIC OF COLOMBIA.

belongs to a British company, and may some day be extended to Banco, on the river Magdalena. On the slope of the Western Andes, an American corporation has in operation a short line of railway, known as the Causa, an extension of which southward to Cali has been spoken of for many years. Other railways actually completed or projected, will be found marked on the map which is included in the present article. It is noteworthy that not ten miles of railway have been added during as many years to the means of communication throughout this vast territory, and that with a single exception, all the projected new lines and extensions were planned a decade or more ago.

With a return of public confidence, begotten of reasonable prospect of even a few years of internal peace, there is no doubt that these and other suspended enterprises would be actively proceeded with. It may be that this time, long hoped for in the Republic itself and by all well wishers abroad, is near at hand, and some encouragement may

LAND AND WATER TRANSPORT—THE OX WAGGON AND THE DUGOUT.

be possibly derived from the fact that within recent months there has been granted by the departmental government of Antioquia to two American miners, Messrs. J. T. Bryan and Charles L. Wright, an important concession for the construction of a railway from St. Lucia, on the frontier of Bolivar, along the valley of the Rio Porce to Medellin, a distance of 180 miles, and thence along the same valley to the source of the Porce and to a termination on the frontier of the department of the Cauca. An idea of the importance of such a line to the department of Antioquia, rivalling that of Tolima in the number and value of its rich gold and silver mines, may be gathered from the fact that it is three days' journey on mule-back from Medellin to the terminus of the present Antioquian Railway, which unites the port of Puerto Berrio with the Magdalena. This is all that now exists of the old Punchart-Mac Taggart scheme, which was found to present many interesting but not overwhelming engineering difficulties, for connecting by railroad Medellin and the Magdalena. The latest proposed railway—in combination with the project for

OLD CARMELITE CHURCH.

A FRUIT SELLER.

connecting Antioquia with Buenaventura, on the Pacific Ocean—could not fail to be of enormous benefit to the Republic. By means of these enterprises, roads to two oceans would be opened from the coffee regions of Condinamarca, the emerald mines of Muzo and Coscuez, in the department of Boyaca, the pastoral and industrial districts of Tolima and the Cauca, the commercial centres of Medellin and Manzalas, and the rich mining regions of the Western Andes, Tolima, and Cauca. At the present time, both silver and gold is being produced in considerable

NATIVE POTTERY READY FOR THE MARKET.

quantities by various British and other mining companies, between whom and the State and federal government amicable relations usually exist. Although during late years work by many of these companies has been frequently suspended, owing to political disorders, their average aggregate output is by no means insignificant. As individual examples of mining activity, I may mention that the gross returns from the Colombian Hydraulic Company's mine at Malpaso, Tolima, from 1873 to last year, were £286,000, while those of the Western Andes Company, an associate enterprise, at Marmato, in the centre of the richest gold district of the Cauca, were £790,000. Than Colombia there is no country in the world where railways—and internal peace—are more urgently required. It is well-populated, rich in agricultural produce and mineral wealth, and brimful of industrial possibilities. Its early development, both directly and in indirect fashion, depends almost entirely on the construction of an inter-oceanic canal through the Isthmus of Panama; and whether or not the Colombian adversaries of that enterprise are sincere in contrary belief, it is very certain that every intelligent foreigner who has lived in or possesses practical knowledge of the Republic is absolutely convinced upon the point.

THE COAL-MINING INDUSTRY OF THE UNITED KINGDOM.

By R. A. S. Redmayne.

HISTORICAL REVIEW OF THE DEVELOPMENT OF BRITISH COAL-MINING.

From the very beginning of the use of mineral fuel, Great Britain has been pre-eminent through her coal resources. They have been the foundation of her enormous expansion as a manufacturing power, and of an export trade which has carried her commerce right around the world. Whatever the future of the United States as a world's workshop and a world's fuel producer, the coals of Wales will long remain the standard of comparison, both as to price and quality. This gives universal importance to Professor Redmayne's comprehensive review of British coal mining, of which the first paper appears below. It has hardly less importance and interest for the light it throws on the broader aspects of the labour question. It is an impressive demonstration of the fact that the progressive introduction of labour-saving machinery has resulted in a constantly parallel rise in the condition and the prosperity of the labourer.—THE EDITORS.

IN 1860, Professor Hull undertook the calculation of the quantity of British coal, in 1863 Sir W. Armstrong drew attention to the question in his address to the British Association, and in the year 1865, Professor Jevons published his well-known book on "The Coal Question," since which time the subject of the duration of British coal supplies may be said to have remained a burning question. In spite of some inaccurate statements and erroneous contentions, Professor Jevons' work will always remain an important contribution on the economical side of the question, and must ever be regarded as being the first attempt to treat fully this important subject. It is thirty-six years since the first Royal Commission was appointed to investigate the probable quantity of coal existing, and other points germane to the question of coal supplies in the United Kingdom. And now another Royal Commission is sitting, having been appointed to undertake a similar though somewhat more extensive enquiry.

In order to have a clear perception of the present, and gauge the potentialities of the future, it is imperative that we should possess a knowledge of the past. This is as true of any branch of applied science as it is of commerce, and in the coal trade, the paramount industry of Great Britain, we have a close combination of these two.

Authorities are not agreed as to the date when coal was first used in Britain as fuel. It is not unlikely that some of the supposed allu-

sions to "coal" in early manuscripts relate to the use of "charcoal," the "colliers" to whom grants of land were made being none other than charcoal burners. So passing over such dubious references, we find the first substantial mention of coal mining in the records of Holyrood and New Battle Abbeys, which show that coal was dug on the south shore of the Firth of Forth before the end of the reign of William the Lion (1200 A. D.). However, the year of the signing of Magna Charta would really mark the birth of the coal trade. Coal then appears to have passed into the hands of subjects along with peat, etc., as a mere surface material not worth mentioning. From this event which gave security of property, coal may be said to have been worked and sold as an article of commerce.

Considerable developments appear to have taken place in the reign of Henry III, and coal came to be worked in most of the coalfields of Great Britain. Turning for instance to the Great Northern coalfield (in Northumberland and Durham)—which has been the nursery of the industry, and in which at the present day will be found collieries that, in point of equipment, output, and management as well as amenities of labour conditions, are unsurpassed in any other mining district in the world—we find about the year 1236 a grant was made to the monks Adam, Alan, and Richard de Camhus, of land on the coast in the vicinity of the present town of Blyth, in which was included amongst other things the right of gathering sea coal (carbone maris) on as much of the shore as belonged to their grant. This is the same place as the modern *Cambois, and the collieries there, owned by the Cowpen Coal Company, now annually raise about one million tons of coal. Three years later Henry III granted a charter to the citizens of Newcastle giving them the right to dig coals in the Castle Field and Firth. The first mention of coal in the neighbourhood of the Midland Metropolis is at Walsall, where, in the time of Edward I, Margery la Rous, lady of the moiety of the town of Walsall, granted to Richard Morteyn and his heirs a moiety of the profit of each manner of mine of sea coal as well as of iron.

These references taken from a number will serve to show that active coal mining, though as yet most primitive as to its methods, was being entered upon throughout the land. The forests were dwindling and coal would be required for burning lime, for building purposes and for smithy work. That coal was also being used for household purposes is shown by the fact that it was imported into London from Newcastle about 1257, though like any other innovations before and

* Pronounced "cammus."

since that day, its introduction was not received with universal pleasure, for we read that the Nobles and Commons assembled in Parliament complained against its use as a public nuisance, corrupting the air with stink and smoke; so that its use was prohibited in London by Royal Proclamation in 1306. However, the loyal (!) citizens paid no heed to the injunction and wisely continued to use the new fuel.

Coal and other minerals were naturally first worked in hilly districts, where the deposits outcropped, and in these early days of coal mining, the working of the coal was carried on by means of an "adit" driven into the seam or by "bell pits" sunk near the outcrop; these were small holes or shafts 3 or 4 feet in diameter put down through a few feet of overlying strata to the seam of coal, and then widened out so as to allow of the excavation of as much coal as possible without causing the overlying strata to fall in; similar, in fact, to the bell pits in Sussex sunk in pre-historic times to obtain flints for the making of stone implements.

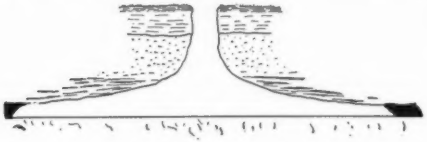


FIG. 1. BELL PIT.

In the fourteenth century, the coal was mined by the shaft and adit method (Figure 2); the adit, which was used to draw off the water, was driven into the side of a hill; the miners by wooden picks tipped with iron drove narrow passages or galleries in the coal seam, and loaded the coal by means of wooden shovels into wicker baskets (called corves), which were either carried or placed on wooden sledges and drawn by manual labour to the shaft bottom, where by means of a jack roll worked by hand it was hauled up the shaft, or in some parts, the Scottish mining districts for instance, it was carried up the shaft on the backs of women. When difficulties presented themselves, such as lack of air or excess of water, the workings were abandoned and a fresh pit sunk—to the depth of a few fathoms—some little distance away. Old shafts can still be seen in ancient mining districts which show the area of the workings to each shaft to have averaged about 10 to 11 acres.

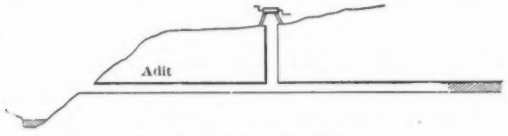


FIG. 2. SHAFT AND ADIT.

But little advance was made in the art of mining during the fif-

teenth, sixteenth, and seventeenth centuries. Water was the great difficulty, the depth and extent of the workings being limited for the most part by the level at which free outlet for the water could be obtained through day drifts (see Figure 2 and 3), and it is worthy of note, in view of the present enquiry into the extent of available

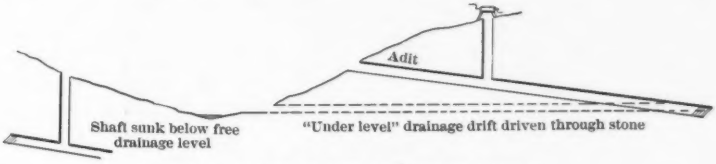


FIG. 3. STAGES IN THE ADVANCE OF MINING.

resources of the coal fields of the United Kingdom by the Royal Commission on Coal Supplies, that in the year 1610 it was stated in Parliament that the coal mines on Newcastle-on-Tyne would not last out the term of their leases of twenty-one years, owing to the maximum depth having been reached.

Attempts were made about this time to raise water in several stages by chain pumps operated by water wheels in the manner illustrated in Agricola's "De Re Metallica" (Figure 4), or by horses; and whim gins worked by horses were substituted for jack rolls in raising the coal.

The manner of raising water from coal mines in Staffordshire has been described by a writer* of the time (1686). He says:—

> "The less gin they call a jack, which is turned by men or horses, as necessary, but the gin is always worked by horses, which likewise is two-fold, either by chain or barrel; the chain is made with leather suckers upon it at little distances; which bring up water and discharge into a trough; the gin by barrel whereof one always goes up as the other goes down, will raise great quantities of water if it be worked day and night."

The ventilation of the mines was most primitive, and there can be no question that as the workings advanced further away from the outcrop and the depth from the surface increased they would be much troubled with fire-damp; but for the first account descriptive of the difficulties encountered in this respect we are indebted to Mr. Roger Mostyn, in a paper prepared by him for the Royal Society in 1677. It was when opening out a new colliery at Mostyn in 1675 that fire-damp was first heard of in that district, and the writer of the paper

* Dr. Plott, professor of chemistry, University of Oxford, in his "Natural History of Staffordshire."

FIG. 4. DRAWING WATER UP A SHAFT BY MEANS OF A CHAIN AND BUCKETS.

From an old print.

tells how that after the workings had proceeded a good distance underground, fire-damp gradually begun to "breed," but was little feared by the workmen who toyed with it with their lighted candles until one of their number was badly burned by it, after which the collieries selected a man from among themselves who being "a resolute man of purpose," was sent down the mine some time before them every morning clothed in his worst rags saturated with water; this courageous individual crawled forwards towards the fire-damp holding a long pole before him, to the end of which were attached one or more lighted candles, and therewith fired the explosive mixture. This came to be the usual mode of dealing with fire-damp—a very dangerous mode; the man who did the "fiering" was termed the "fireman," and so was originated a class of men whose duty it is at the present day to inspect the workings before entrance of the workmen, and who in some mining districts are still designated "firemen," and in others are known by the name of "deputies" (deputy overmen). For a graphic description of an explosion at Mostyn Colliery, the earliest account extant, the reader is referred to the paper alluded to above.

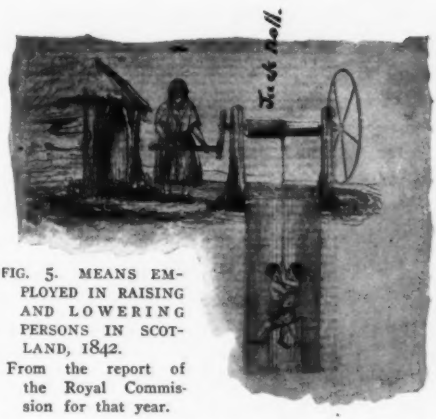


FIG. 5. MEANS EMPLOYED IN RAISING AND LOWERING PERSONS IN SCOTLAND, 1842.
From the report of the Royal Commission for that year.

Grey, the earliest historian of Newcastle, writing in 1649, said the coal trade only "began not past four score years since; coals in former times was only used by smiths and for burning of lime," although we have seen that it was used as early as the fourteenth century for domestic purposes in London; but there is no doubt that the reign of Queen Elizabeth saw considerable widening of the demand for coal.

Several attempts were made in Staffordshire in the early part of the seventeenth century to make iron with pit coal, and in 1619, that great benefactor of the coal and iron industries, Lord Dudley, succeeded in accomplishing this, and at his first trial, by means of coal, successfully smelted iron at the rate of three tons a week. It is possible, too, that the expansion of the trade was assisted by the invention of coke, alluded to in those days as the "charring" or "charling" of "sea-coal," a process which was patented in 1620 by one Hugh Grimsby and also about the same time by Sir John Hacket in conjunction with Octavius de Strada, so that said the latter, it "might be used in houses without smell or smoke."

Tho coal trade, however, does not seem to have been enjoying universal prosperity in the middle of the seventeenth century; doubtless it was experiencing one of those cycles of depression, due in all probability to over-supply, which have proved so characteristic of the more recent history of the industry. Grey in his "Chronographia" published in 1649, says:—

> "Many thousands of people are employed in this trade of coals, many live by working them in pits, and many live by carring of them in wagons and waines to the river Tine; many men are employed in carrying the coals in keels from aboard the ships; one coale merchant employs 500-1000 in his works of coale—yet, for all his labour and care, and list, can scarcely live of his trade: nay, many of them have consumed and spent great estates, and dyed beggars, and our coal miners they labour and are at great charge to maintain men to work their collieries. They waste

> their own bodies with care, and their collieries with working, the kernel being eaten out of the nut, there remaineth nothing but the shell; their collieries is wasted and their monies is consumed; this is the uncertainty of mines—a great charge, the profit uncertain."

Not an inapt epitome of the views of a present-day coal owner when the trade is depressed. "Master Beaumont" is also mentioned by the writer from whom we have quoted as having "adventured £30,000, expended on rare engines &c. and consumed all his money and rode home on his light horse," and he sapiently remarks "There's a swarm of worms underground that will eat us all before their time. They may find some *ignis fatuus* instead of a mine."

From this time and from remote antiquity, the method of breaking down the stone when driving passages through hard rock (stone drifts) and sinking shafts was to heat the rock with fires and pour water on it and so split it, and it is interesting to note that traces of breaking rock have been found in the ancient workings of the Rhodesian gold mines. Gunpowder was first used for blasting in the metal mines of the Mendip Hills (1683), but not until 1719 was it taken advantage of in coal mining in the United Kingdom, when it was used for sinking through hard rock in Somersetshire. Its use enabled more difficult mining operations to be undertaken, and the invention of the atmospheric engine by Newcomen in 1710 (see Figure 6) introduced new and improved methods also, changing in fact the whole aspect of the industry. Until that time 60 fathoms was about the maximum depth of shafts—their diameter 7 or 8 feet, the workings seldom extending beyond a radius of 200 yards from the shaft. But in 1760 Walker Colliery on the Tyne was sunk to the depth of 100 fathoms to the main coal seam, a medal being struck to commemorate so unprecedented an event, and in 1763 a pumping engine was erected having a cylinder 72 inches in diameter and 10 feet 6 inches long.

It was not, however, until the year 1780 that the atmospheric engine was applied—at Willington Colliery in Northumberland—to drawing coal up the shaft. And the first Boulton and Watt engine with a closed-top cylinder was erected at St. Anthonys, near Newcastle, in 1790. It is remarkable that some of these antiquated types of engines are still to be seen at work at mines in South Staffordshire.

The difficulty of procuring sufficient light whereby to work in "fiery" mines before the era of the safety lamp can be easily imagined. The choice would lie between the dim light obtained from the phosphorescence of suspended fish skins, and the possibility of being burnt by the ignition of fire-damp, until the invention of the steel mill by

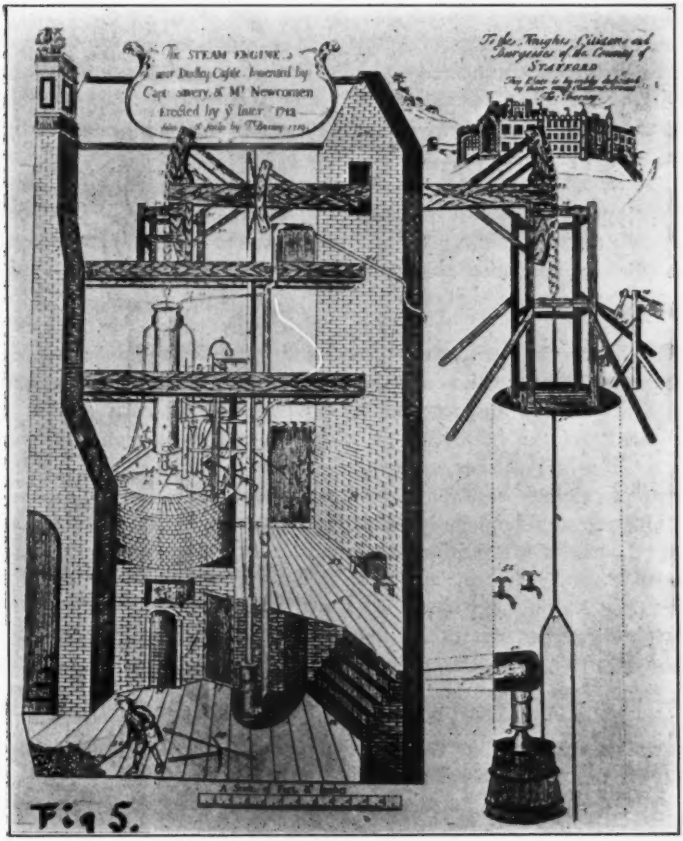


FIG. 6. THE FIRST STEAM ENGINE.
Erected at a coal pit in Staffordshire in 1712. An old print.

James Spedding in 1760—a machine consisting of an iron frame supporting a steel wheel which was made to revolve against a flint, producing thereby a shower of luminous sparks; but even this contrivance appears not to have been very safe, for an explosion due to its use is recorded as having occurred at the Wallsend Colliery.

Great improvements were also being made in the ventilation of the underground workings of the mines; hitherto it had been customary to ventilate only the working face by the one continuous current; now, however, (1765) the method known as "coursing the

air" was introduced, whereby the air current was forced, by an arrangement of stoppings and doors, to sweep through nearly every part of the mine from the point of inlet (downcast shaft) to its exit (upcast shaft).* If the air current was taken up one row of pillars and down the next it was said to be courses "one and one," if one row was missed and it was taken back by the second it was "coursed two by two," and so on. The ventilation was still further improved by the system of "splitting the air," which was the idea of Mr. John Buddle (1807), a mining engineer of great note in his day, sometimes described as the father of the Northern coal trade; this was known as the compound ventilation, and is in vogue at the present day. The mine was divided by barriers into districts or "panels," each district having a separate ventilating current split off from the main current, in place of being ventilated by a current perhaps already fouled with gas from another district; the length traversed by each current is shorter, hence the ventilating pressure required is less—an important matter in a large colliery. It therefore meets the two great requirements of mining—safety and economy.

Underground haulage had already been improved by the introduction of horse in substitution of manual labour for pulling the coals to the shafts, and coals were selling at Newcastle (1765) at from 12 shillings to 15 shillings per chaldron (a chaldron was equal to 3 tons).

In view of the present day industrial combinations and trusts, it is of interest to note that a union of colliery owners shipping coal from the rivers Tyne, Wear, and Tees, was formed in 1771, with the object of raising the price of coal to consumers by restricting the output, known then as the "limitation of the vend." This alliance existed with but few temporary interruptions until the year 1845.

The considerable improvements in the steam engine made by James Watt led to further advancement in the method of winning and working at the commencement of the nineteenth century. And the employment of coal in the manufacture of gas (about 1803) gave a great impetus to the coal industry. Tubs or colliery trams were invented by a colliery viewer (manager) named Carr in Yorkshire in 1797—as also guides for shafts; the trams held 5½ to 6 cwts., and ran on small wheels on wooden tramways, and later on rails, but it was not until about 1836 that the invention was generally adopted throughout Britain. The replacement of the wicker corf by an iron cage for holding the trams in their transit up the shaft soon followed.

* There was but one shaft, the downcast and upcast airways being compartments formed by wooden bratticing in the same shaft.

Deeper shafts and more extensive workings brought in the era of big colliery explosions, of which unfortunately we have not yet seen the end, though an appreciable diminution is noticeable during the last decade, due doubtless to our better knowledge of the part played by coal dust in such catastrophies. Repeated disasters in the pits led to the formation at Sunderland in 1813 of a "society for the prevention of accidents in coal mines," and it was the members of this society who were instrumental in engaging the services of Sir Humphrey Davy in the investigation which culminated in 1815 in the invention

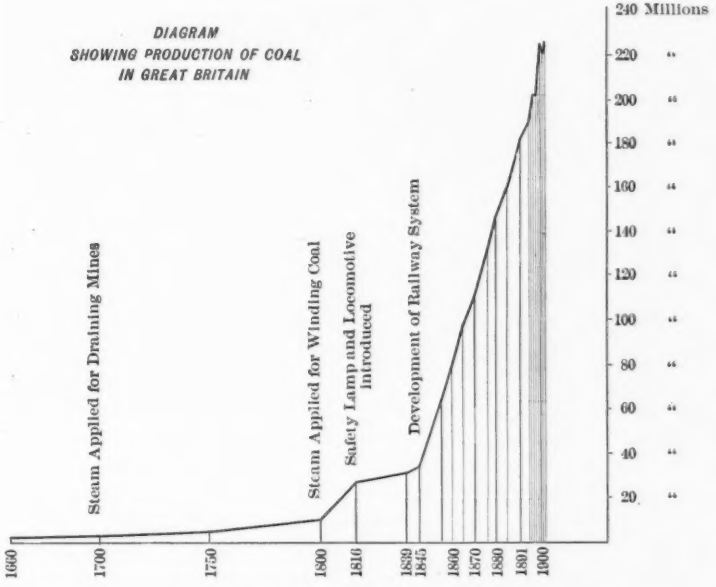


FIG. 7. PRODUCTION OF COAL IN GREAT BRITAIN, 1660 TO 1900.

of the safety lamp. Many safety lamps have since appeared, but the principle underlying their construction—other than those in which the light is electrical—is the same, viz., that if a gas flame is brought in contact with a cool material the flame is extinguished and the gases pass away unburnt. Sir Humphrey Davy secured this object by surrounding the flame of the candle with a cylinder of wire gauze, (the mesh of which contained 784 apertures in a square inch), about 1½ inches in diameter and 7 inches high, covering the top with a cap of the same material; the air could pass in freely, but should gases

enter and fill the interior with flame, as soon as the flame touches the gauze it is instantly cooled and cannot pass outside unless the gauze itself become red hot, or the lamp be rapidly moved or the inflammable vapour strike the gauze at a high velocity. This invention undoubtedly led to still further extension of mining operations.

The following table and the diagram (Figure 7), giving the output of coal for the United Kingdom at various stages of the history of the trade, shows how the augmentation was contributed to by the introduction of various improvements and inventions connected with the art of mining.

Year.	*Output of coal in tons (2,240 lbs.)*	*Authority.*
1660	2,148,000	Estimated by the Royal Commission on Coal, 1871.
1700	2,612,000	" " "
Steam applied to draining mines. Gunpowder used in mines.		
1750	4,773,828	" " "
Steam applied to drawing of coal. Development of the canal system (1760-1800).		
1800	10,080,300	" " "
Coal used for manufacture of gas (1803).		
1816	27,020,115	Estimated by Samuel Salt.
Invention of safety lamp.		
1845	34,600,000	Estimated by J. R. McCulloh.
Steam boats and the development of railway system.		
1855	64,307,000	Estimated by Roy. Com. on Coal, 1871.
1860	84,042,698	Official Returns.
1865	98,150,587	" "
1870	112,875,525	" "
1901	219,046,945	" "
1902	227,178,140	" "

As to the condition of the mine workers nothing has been said in this article, nor is it proposed to enter into a detailed consideration of this side of the question, but it may not be generally realised that in Scotland in the middle of the eighteenth century colliers were working under laws by which they were practically slaves; able bodied men were paid 10 pence per day for hewing coal, the womankind acting as bearers in carrying the coal out from the workings and re-

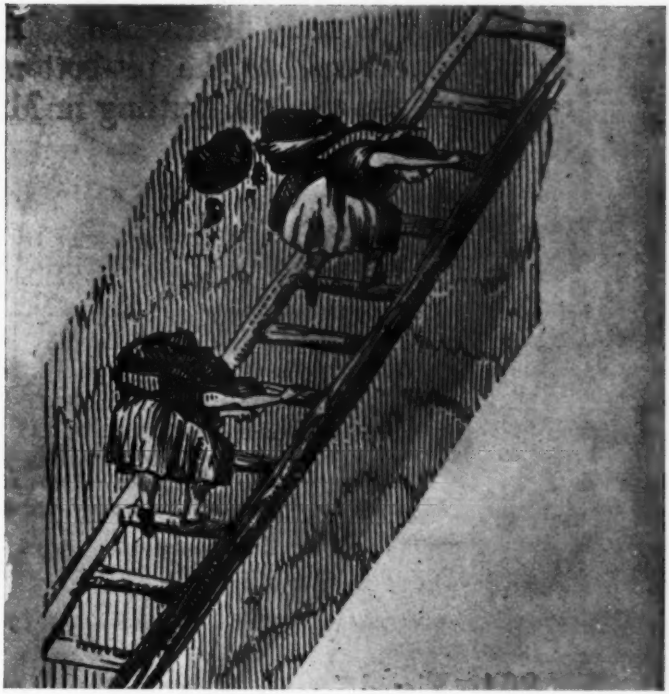


FIG. 8. WOMEN CARRYING COAL UP A SHAFT IN SCOTLAND.
From Report of Royal Commission, 1842.

ceiving but 3 pence a day. The workers, forming part and parcel of the concern, passed from owner to owner with the colliery as so many chattels. In 1778 a law was passed which enacted that this state of life slavery should come to an end, the emancipation to be gradual; but it was not until 1799, when another act was passed, that their complete freedom was granted to them. It is only right, however, to point out that the pay and conditions of employment of the mine workers in other parts of Britain were in advance of those of Scotland, and that although women were employed about this time in the majority of mining districts in underground haulage, it was only in Scotland that they were made to carry coal up the shafts.

The middle of last century may be regarded as a transition period in the history of coal mining in Britain. The ventilating furnace was already in operation, and mechanical ventilators were being intro-

duced. Hempen ropes were being replaced by those constructed of iron wire (1840), and underground haulage soon came to be effected by mechanical means. The railway system was developing, and steam-driven machinery was coming to be universally applied to mining operations, enabling collieries to be worked to greater depth and extent, and increased individual outputs to be obtained. Underground inspection by Government officials was introduced by Act of Parliament in the year 1850, and in 1860 further legislation resulted in the passing of the Mines Regulation and Inspection Bill. The great disaster at Hartley Colliery (Northumberland) in 1862, whereby 204 men lost their lives, showed the need of having a second and separate outlet from the mine, and the Act compelling the sinking of two shafts became law as a consequence. Ten years later (in 1872) the Comprehensive Coal Mines Regulation Act was passed, since which much stringent State regulation has been imposed, with the view in a great measure to the protection of the persons and interests of the miners. Socially, morally, and financially the status of the workers has greatly advanced during the last sixty years, and coal mining has developed into a branch of engineering requiring the services of the most skilful and highly trained engineers.

The next article will deal with the period covered by the last 30 years—the condition and state of the mines, the engineering developments, and the social and financial position of the workers.

A WOMAN DRAWING COAL FROM A LANCASHIRE COLLIERY, ABOUT THE MIDDLE OF THE 18TH CENTURY.

ELECTRIC TROLLEY VEHICLES WITHOUT RAILS.

By Emil Guarini.

Col. Stewart has recently and well pointed out in these pages (July, 1903) that the steel rail, rather than mechanical traction, is the more important element in the economy of haulage by motor vehicles. M. Guarini, however, takes up a special case only—that in which the density of the traffic is not sufficient to justify the installation of the railway, and yet some of the advantages of centralised power generation and electric traction may be realised while preparing the way for the fuller development by the tramway later.—THE EDITORS.

ELECTRIC traction by means of the trolley, but without the steel-rail roadway, unites to the advantages of ordinary electric traction those of economy in the first cost of exploitation, and of better utilisation of equipment. It involves a far smaller outlay than a tramway or any form of traction requiring the steel roadbed, which in its installation and its upkeep, together with the support of its administrative staff, is so expensive that the undertaking as a whole sometimes becomes little or not at all remunerative.

It is not at all to be inferred from this that a traction installation on ordinary roads, taking current from ærial feeders but running its vehicles without the metal tracks, would be always and everywhere superior in economy to one employing rails for its way. The problem and its solution vary with each special case. Indeed, by reason of the much greater tractive effort required when a vehicle is not running on rails, the current demanded in such case is also much greater. It rises further as the road surface becomes poorer. If the current is supplied at a low net cost, as in some cases of hydraulic utilisation, this excess demand for power may not become a serious item in the account. It may be quite the contrary, on the other hand, if, as in many cities, the cost per kilowatt of electric power is very high.

There are other factors, also, which can not be left out of the count. By no means least of these is the necessity, in the case of electric traction without rails, for two metallic conductors in place of the one employed when, as in the railway, the return circuit is made by the steel rails. But here I seek indulgence in a digression. There are, among electricians, two parties on the question of earthing the return circuit. The first would abandon entirely, in traction work, the return by the

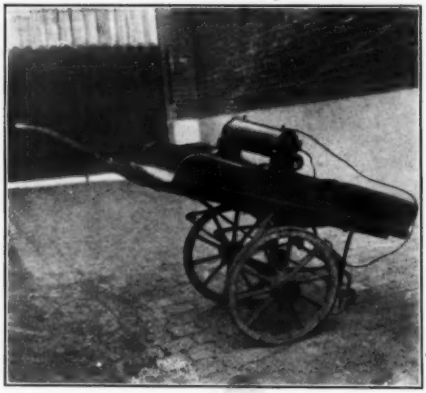


FIG. I. WIRELESS TELEPHONE APPARATUS.

rails and the ground, alleging as objection the resulting perturbations in telephone, telegraph, and other weak-current circuits. The second, very reasonably, in my opinion, are unwilling to renounce the economical advantage resulting from the use of the earth in place of an often very expensive metallic conductor. They would seek rather to discover and provide some means of correcting the disturbances of the feebler systems, and would adopt the earth return not only for electric traction lines, but for all electric power systems. The International Society of Electricians is applying itself to the solution of the problem.

I myself have quite recently verified a means which, I hope, at least, may serve to solve the question in the most complete and general manner. This means which I have tested is generally analogous to the three-wire distribution system. It consists in dividing the power current between two circuits, both earthed at every pole, the earth connections of the respective circuits at each pole having opposite polarities. If the intensity of the current is substantially equal in the two circuits, a very sensitive galvanometer placed in circuit with two earth connections close to those of the power circuits will not indicate any current (Figure 2). In other words, what is needed is to neutralise, by a charge of contrary sign, the charge which each ground of the galvanometer circuit (telegraph, telephone, etc.) receives from the current from the earth plate connected to the dynamo.

But how is return through the earth to be effected when the vehicle is in motion over the pavement—that is to say, on a roadway not laid with rails? The difficulty depends upon the tension of the current employed. Suppose, for instance, that the current taken from an overhead wire, after traversing the motor of a vehicle, leads to the metal tires of the wheels running on the roadway. Unquestionably that would be a very bad ground connection; but what do a few dozen ohms' resistance matter when the pressure is thousands of volts? I say thousands advisedly, for there is nothing startling in the statement

after the Zossen-Marienfeld experiments, in which a current of 12,000 volts was used directly in the traction motors. I personally have made experiments in wireless telegraphy from a moving vehicle, using a telephonic receiver and, as return, the wheels of a truck resting on the street pavement (Figure 1). The tension was 30,000 volts. The aerial wire led first to the fine winding of a transformer and thence to the wheels. The telephone was in the primary of the transformer. At the intensity employed in the transformer there was no difference in intensity of the sound to be detected in the telephone, whether the grounding was through the wheels resting on the pavement or through a rod sunk deep in moist ground.

To return from our digression, let us take up the various applications of electric traction without rails—electric haulage or towage of boats, the electric omnibus, and the electric dray.

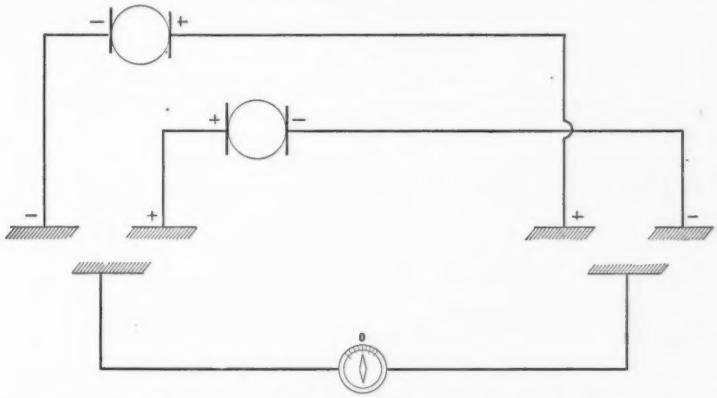


FIG. 2. METHOD OF CORRECTING DISTURBANCES CAUSED BY DYNAMO CIRCUITS.

For the movement of canal boats by electric power two systems are in use, both with many minor modifications; these are electric towage and electric haulage. The electric tow boat is far more economical than the steam. According to the calculations of M. Léon Gérard, the possible economy of the system amounts to 29,000 francs per year for 100 horse power employed 20 hours a day for 300 working days, with coal at 15 francs a ton (metric). As compared with haulage, it has the further advantage of reducing the cost of upkeep of equipment to a minimum, and that of upkeep of the tow path to zero. At a speed of 4 kilometres (2½ miles) an hour, there is no damage to the banks. At higher speeds the banks may be injured, on account of the bad

lines of the boats; but if, as in the Merwede canal in Holland, the banks are sufficiently protected, towage requires no changes in the traffic movement and none in the bridges, quays, or other structures.

On the other hand, as compared to haulage, simple towing has the defects of lower efficiency (32 : 45, or even 32 : 65), of higher power requirements (3.1 : 2.2) and of higher coal consumption (3.37 : 2.75). But the upkeep of the towing path or roadway and of the rolling stock offsets the economy which haulage otherwise shows over towage.

The trials made by M. Gérard on the Charleroi canal in 1901, with a polyphase lateral line and small boats of 60 centimetres draught and 12 horse power, showed very good results. Although the towing craft was 25 metres away from the line, the trolleys worked perfectly and left the boat its perfect mobility. The speed was 10 kilometres (6.2 miles) an hour. The weak point was the efficiency. With screw and gearing it fell to 30 per cent. With large tow boats permitting direct coupling of the motor this might have risen to 38 per cent. The efficiency, in straight canals, might even rise to 80 per cent., if in place of simple towage use were made of cable-warping towboats, which furthermore are practical in handling and inexpensive in maintenance.

In fine, electric towage does not give an absolute solution of the question of electric traction on canals, but it may be advantageous in certain cases, depending on the locality and the traffic of the canal. In such cases it will undoubtedly spread by virtue of its superiority to any other method. It may be remarked further that nothing could be simpler than the considerable reduction of the installation costs of a towage system by the replacement of the return conductor by earthing the circuit. This can be effected by a plate immersed in the water.

Electric haulage, like electric towage, fails to furnish a final solution of the problems of canal traction. Three systems have been successively tried—the Köttgen rack system, the smooth rail, and traction without rails. Of these the last only belongs properly to our subject. Traction upon the bank and on a common roadway is certainly a more practical proposition than the rack system, as proved by three years' experience on the French canals (Gaillot system) and by that of one year on the Charleroi canal (Gérard system). The total efficiency may reach 75 per cent., but the art of the civil engineer must be called into play to make the application practical and its best possibilities realisable; for the profile of the canal, its state of upkeep, and the character of the road over which the haulage motor runs may vary the total result in the ratio of 1 : 3. The system has the general advantage of demanding less initial outlay.

FIG. 3. ELECTRIC OMNIBUS (SCHIEMANN-SIEMENS & HALSKE SYSTEM), BIELA VALLEY LINE.

In the Charleroi experiments referred to above, the supply network received polyphase current at 6,000 volts, 40 periods. An electric central station supplied a stretch of 47 kilometres. The wheels, though of Martin steel, suffered rapid deterioration and serious deformation. In fine, traction on the tow path under the conditions prevailing on the colliery canals of Belgium has not equalled the hopes of its inventors. The demonstrated difficulties are removable, and arise from the character of the road surface. The experience gained led to trials of electric canal haulage on a track laid with smooth rails, but these results are somewhat outside of our present scope. The comparison of the figures, however, sufficed to show that electric haulage on the canal

bank could be successfully employed only if the roadway for the motor vehicle were broad, perfectly built, rolled and macadamised, costing in the total more than a light railway sufficient for the 2,000 or 3,000-kilogramme motor trucks requisite for the service. From all points of view—economy of installation, of maintenance, and of current requirement, canal traction on rails seems superior to traction on the tow path surface.

But if electric traction on navigable waterways does not appear yet to have emerged from the phase of experiment, electric traction without rails but with current supply from an overhead wire seems to have established itself definitely as a practical method of land transportation. It promises even a new activity for that industry which in our era has seen so wide an extension. Not all the many transportation enterprises have been fortunate, but their multiplicity shows that facility of communication is one of the great needs of modern society. It is not sufficient, however, to prove the existence of a need; it is requisite further, in commercial exploitations, to measure the importance of that need and proportion the financial effort thereto. This rule has been at times overlooked, and lines have been built at a cost which it was beyond their physical power to repay. The economic error has been the idea that the rail has always been considered the essential basis of any public transportation system. But the construction of a permanent way laid with rails necessitates a large capital outlay, demanding in its justification a volume and density of traffic which often does not exist.

When the automobile came upon the scene, it was thought that here would be found the proper solution for lines of light traffic. Unhappily, the steam boiler, the steam engine, and the oil motor accommodate themselves but ill to the difficulties inherent to road traffic with vehicles of large capacity. On the other hand, the electric motor is the motor *par excellence* for automobilism; it is incontestably the cheapest to maintain; it is free from vibration; it may be hermetically sealed. But this motor demands a source of energy; if this energy is supplied by accumulators, the weight is immensely increased, and to the maintenance costs are added those occasioned by the battery. Naturally, it was sought to utilise the special qualities of the electric motor while avoiding the defects of the storage battery. The tramway with its tracks answered the question by taking the necessary power from an overhead wire connected with the central station. But the method which is entirely simple in the case of the tramway, whose path is fixed and invariable, is inapplicable to the automobile, which must be

unconfined and free in its movements to avoid the obstacles of the road. It was first proposed to make use of little carriages, rolling on the trolley wire, connected to the vehicle by light flexible cables and towed by these. This solution was not practicable. The little trolley carriage, dragged along by an outside force which was continually varying its direction, became jammed, derailed, breaking its connecting cable or damaging the trolley wire. This difficulty has been met in two ways—by using rigid trolleys, and by making the trolley carriage automobile.

FIG. 4. ELECTRIC OMNIBUS OF THE SOCIETA ALTA ITALIA.

Under these conditions the system has been practically developed, and possesses, besides the general advantages of electric traction, that of being applicable in cases where a track could not be laid—where the curves would be very heavy and sharp, or where the authorities object to the laying of rails on account of the damage to the roadway. Two systems are in actual use—the Siemens & Halske and the Lombard-Gérin.

The Simens & Halske experiments date back to 1882. A trial

ground was established in the outskirts of Berlin, and on this was run a light carriage, the front axle of which was provided with steering gear, while the rear axle was driven by two motors hidden under the seat of the driver. Current was taken from two copper wires hung on wooden poles by the side of the roadway. Upon these wires ran a small eight-wheeled carriage which was kept from overturning by a rather heavy weight. This small carriage was drawn along after the motor vehicle by a flexible cable. More urgent affairs caused the suspension of the trials until the time when the company, in connection

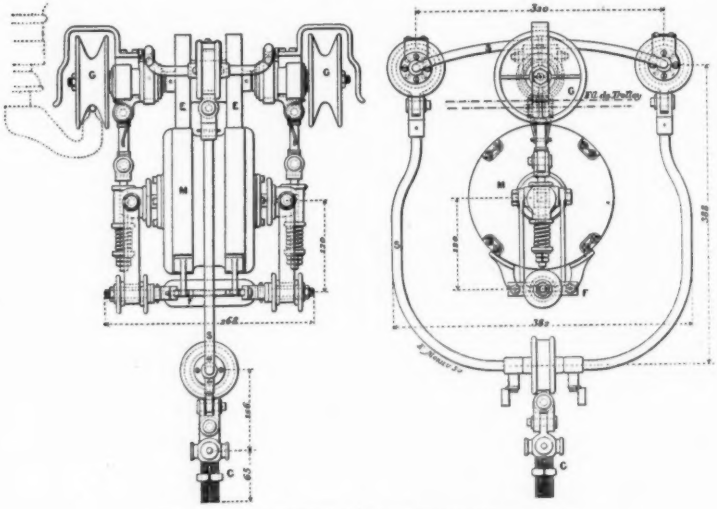


FIG. 5. THE LOMBARD-GÉRIN AUTOMOTOR TROLLEY.

with M. Max Schiemann, built the new electric omnibus system which since July, 1902, has operated in the Biela valley (Figure 3). The line has an extent of 21 kilometres, extending from the bottom of the valley to the Königstein station. The speed attained is 12 kilometres an hour. Nowhere has it been necessary to make any changes in the line, except the placing of the ordinary cross arms carrying two wires, the second serving for the return. Contact is made by two trolleys, formed of light steel tubing and so flexible that the vehicle may deviate a distance of three metres either side of its normal path without their losing the wire. Steering is by the front wheels, and the omnibus has a single compartment.

It is these two latter features which distinguish these vehicles from

those supplied to the Societa Alta Italia and exhibited as features of much interest at the last exposition at Turin. The Italian carriages (Figure 4) are divided into two compartments and carried on two two-wheeled bogie trucks connected by transverse straps forming the diagonals of a rectangle of which the axles are the opposite short sides. By this system all four wheels give direction to the vehicle; when it is steered aside or around a curve, the two wheels on one side approach nearer together while the two wheels on the other side spread wider apart. The arrangement is peculiarly suited for turning very sharp curves or corners.

The second solution of the difficulty of maintaining contact with the overhead wires is furnished by the Lombard-Gérin automotor-trolley system. In this, the trolley carriage is not towed by the motor vehicle; it is equipped with an electric motor and is itself automobile. A simple automatic mechanism secures synchronism of speed between the trolley and the vehicle, without any intervention on the part of the driver. The automotor trolley runs ahead, and keeps a certain tension on the flexible cable connecting it to the vehicle. This tension permits the trolley wire and cable to be maintained at a proper height above the ground on either ascending or descending grades. The length of the flexible cable is proportioned to the width of the road. It is attached to the vehicle by an easily uncoupled electric connection.

The trolley itself (Figure 6) in almost all its exposed parts is made of aluminium and does not weigh more than 20 kilogrammes, sufficient to assure its adherence to the overhead wires and to maintain proper tension of the flexible cable. The triphase motor of the trolley (M, Figure 5) is suspended between the wires and below them, by a frame resting on the shaft which carries the sheaves G, rolling on the trolley wires. The motor has a fixed field magnet while the revolving armature drives by friction the fibre wheels E, mounted on the shaft of the rolling sheaves, and thus propels the trolley carriage. Suspension screws and nuts give the proper tension. 500-volt direct current is taken from the wires by the rolling sheaves, and transmitted by two conductors, contained in the flexible cable, to a pole fixed on the top of the vehicle, and thence through the controller to the motors. A very simple device—three collector rings attached to these motors and connected to the proper points in the winding of the armature—allows three-phase current to be taken off, the motor thus serving as a converter, independently of its functions in driving the vehicle. This triphase current collected by the three rings is transmitted by three wires also enclosed in the flexible trolley cord.

The speed of a triphase motor being synchronous with the current which supplies it, it follows that the motor of the trolley revolves automatically at a speed proportional to that of the motor of the vehicle. The relation is so adjusted that the speed of advance of the automotor trolley shall always be slightly greater than that of the omnibus and thus the cable always be tense. The connection of the cable to the automotor trolley is by universal-joint suspension, so that the pull of the tension is always in the bisectrix of the two wires and never produces any torsional strain. Besides the wires already mentioned, the flexible cable contains a sixth, operating a small electro-

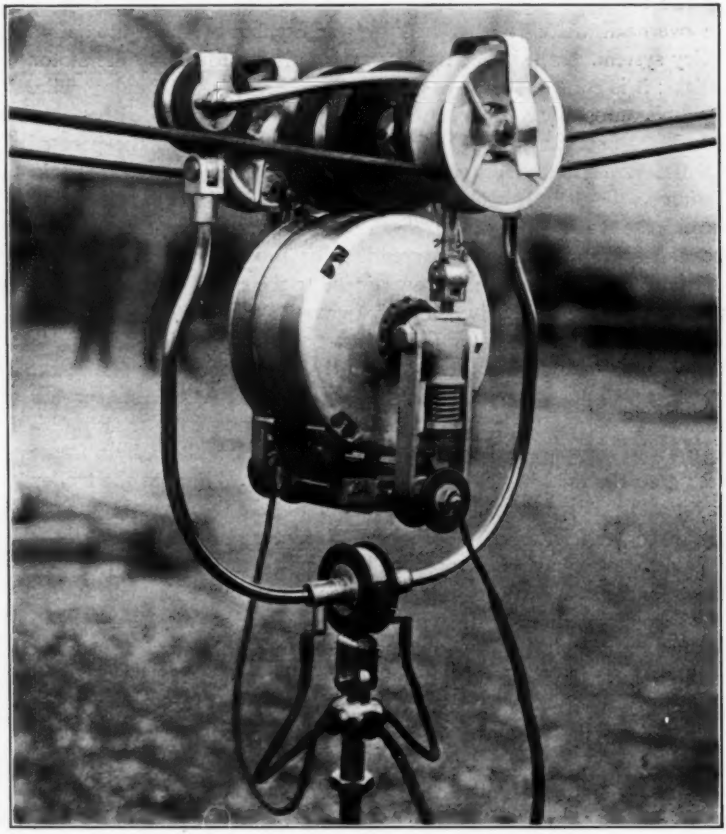


FIG. 6. LOMBARD-GÉRIN AUTOMOTOR TROLLEY.

magnetic break, F. This allows of blocking the trolley carriage on the wire in case of need, as for example if the vehicle is stopped on a hill.

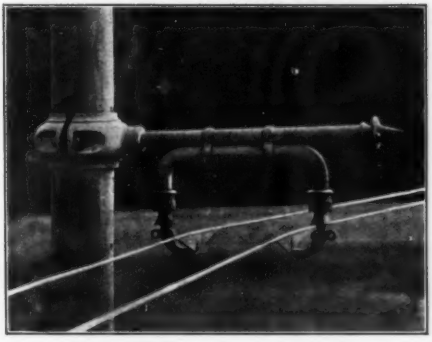


FIG. 7. TROLLEY WIRE SUSPENSION, LOMBARD-GÉRIN SYSTEM.

The trolley lines in this system are two parallel copper wires of 8 millimetres diameter, stretched 30 centimetres apart. The malleable bronze pieces supporting the wires are screwed into ambroïne (porcelain) insulators fixed upon C-shaped pieces and either fastened to brackets, where the line is at the side of the road (Figure 7), or suspended when it is in the middle of the roadway (Figure 8). The C-shaped pieces are made of iron tubing and permit the passage of the automotor trolley. The vehicle is very comfortable (Figure 9); the controller, besides speed changes, permits the stopping of the trolley by means of the break already described. A commutator also permits the direction of movement of the trolley to be reversed. The front wheels are steering wheels, the rear, driving wheels. These are separately chain driven, each by an 8-horse-power motor.

From the point of view of manœuvering, the "railless omnibus," of either system, is indisputably superior to the tramway. It can with the utmost ease avoid obstacles, pass or make way for other vehicles (Figure 10), turn, even with the rigid trolleys (Figure 11), and cross. If two omnibuses on the Lombard-Gérin system meet, they exchange trolleys (Figure 12) the operation taking about one-half minute. If the vehicles are of the Siemens & Halske type, one of them stops and lowers

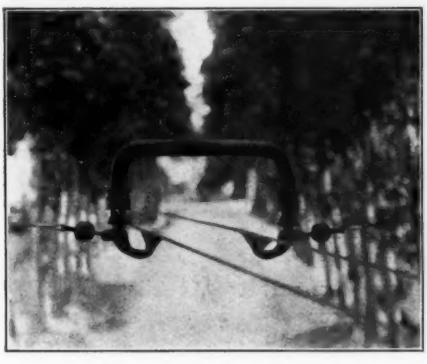


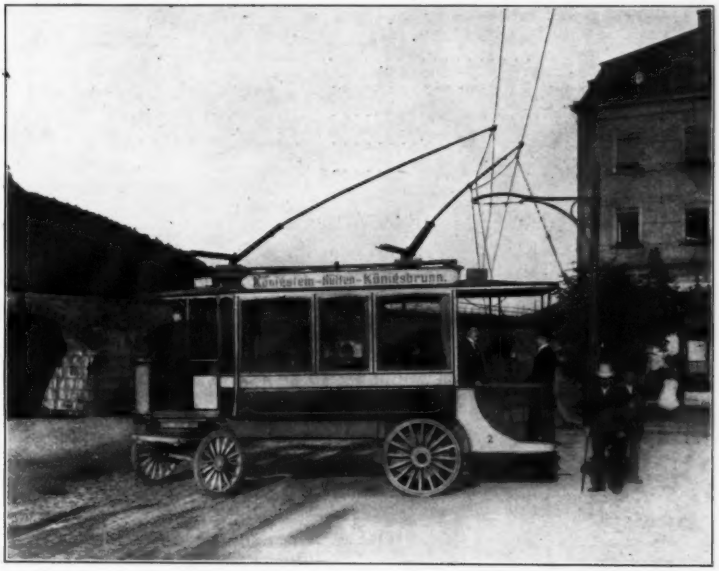
FIG. 8. TROLLEY WIRE SUSPENSION, LOMBARD-GÉRIN SYSTEM.

its trolleys and the other turns out and passes by as shown on page 48.

To take up now the advantages claimed for the traction without rails, I may borrow from a *brochure* of the "Compagnie de Traction par Trolley Automoteur." For a tramway, the construction cost will be at least 30,000 francs per kilometre, and the gross expense 2,800 francs per kilometre per annum. These charges may or may not be justifiable, depending on the frequency of the service. On a 5-minute, 10-minute, or even a 15-minute headway, the expense per car-kilometre is relatively low; with a lower frequency of car movement it assumes serious importance and becomes prohibitory when half-hourly or hourly departures are all the traffic conditions will support. Whenever, therefore, the vehicles must be run at long intervals, the track must be dispensed with and the electric omnibus installed, the more that the rails may be installed without the loss of any useless outlay, whenever the increasing density of traffic justifies. The net cost of either service depends on the following five factors:—Cost of electric power personnel employed on the vehicles; maintenance of vehicles and car houses; maintenance of the overhead wires; administration, general expense, and sundries. The omnibus evidently has not so high a co-efficient of tractive efficiency as the tram car. The results determined for the Siemens & Halske system were:

FIG. 9. INTERIOR OF LOMBARD-GÉRIN TROLLEY OMNIBUS.

	Omnibus (kilogrammes).	Tram Car (kilogrammes).
Weight	4,500	10,000
Starting effort	400 to 500	500
Normal requisite tractive effort		180 to 210
On good roads	270, mean	
On bad roads	500, maximum	



FIGS. 10, 11. TROLLEY OMNIBUSES TURNING OUT FOR VEHICLES AND TURNING AROUND AT THE END OF A RUN.

This factor, however, has but minor importance on account of the difference in dead weight. In the tramway, this is at the lowest 233 kilogrammes per passenger; in the omnibus, it does not exceed 159 kilogrammes per passenger. In both cases the consumption of current is about 50 watt-hours per ton-kilometre per each one per cent. of grade. Upon calculation of the relative consumption of the two types of vehicle, it will appear that the consumption is decidedly less for the omnibus, and that the economy reaches 30 per cent. on a 7 per cent. grade. On the other hand, the excess cost of the omnibus on level roads is but 1 centime per car-kilometre, an insignificant figure when compared with the expense attendant upon maintenance of way, which may be taken at 2 centimes per car-kilometre on a 5-minute headway. The wages cost and the upkeep cost of the rolling stock are substantially the same in both cases; those of repair of the overhead wire are higher with the omnibus. General and administration costs are naturally variable; they may be averaged at 5 centimes per car kilometre for tramway and 4 centimes for the omnibus. In total, the expense per car-kilometre, not including that from the maintenance of way or the interest and amortisation on its cost, may be thus summarised:

	Tramway.	Omnibus.
Electric power	8.4 centimes	9.5 centimes
Wages on vehicles	9.0 "	9.0 "
Upkeep of vehicles and sheds	5.0 "	5.0 "
Repairs of overhead wire	0.5 "	1.0 "
Administration and general	5.0 "	4.0 "
Total (Track costs excluded)	27.9 "	28.5 "

To take a concrete example of the possible benefits of the omnibus system, let us suppose a line of 5 kilometres length with an hourly service. For an electric tramway, the initial cost of installation would be 240,000 francs; for an omnibus line, 100,000. The working expenses of the tramway would be 12,750 francs per annum; for the omnibus line, 9,000 francs. Assuming gross receipts of 16,000 francs, the tramway would have a net earnings of 3,250 francs—1.3 per cent. on its capital; the omnibus enterprise, net earnings of 7,000 francs—7 per cent. on its capital, or five times as high a rate of dividend as the tramway.

It is apparent without explanation that the trolley vehicle running on the ordinary road may be used in goods transport as well as for passengers. A demonstration of this by the Lombard-Gérin system

was made by a waggon which ran for some time from Porta Pia to Rome, and also on the line between Chillon and Lake Geneva. On the Biela valley line, operating under the Schiemann-Siemens & Halske system, also, goods were carried in a small two-wheeled truck coupled behind the omnibus, for the carriage of luggage and packages. The trials have worked well and larger waggons are planned. The Biela line is not destined merely for the transport of passengers. It is assured of an important goods traffic, principally between the saw-mills and paper mills at one end of the line and the goods station of Königstein, at the other end.

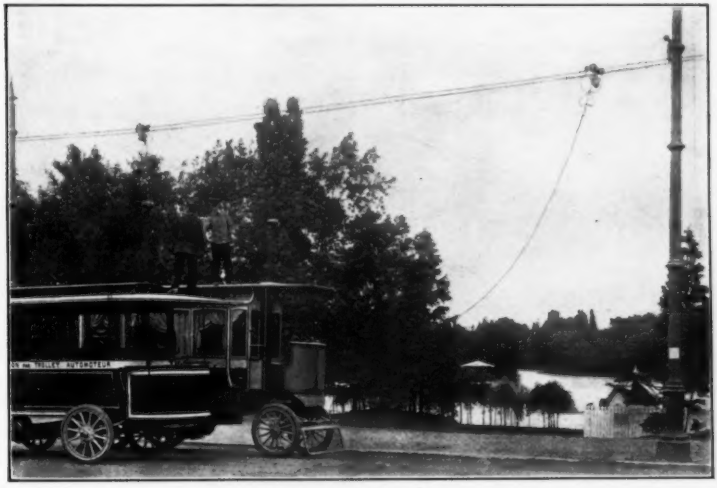


FIG. 12. TROLLEY OMNIBUSES, LOMBARD-GÉRIN SYSTEM, EXCHANGING AUTOMOTOR TROLLEYS AT A MEETING POINT.

The Schiemann-Siemens & Halske system is in use also at Grevenbrück in Westphalia, where it was recently installed for the transport of limestone from the quarries to the railway. Each truck carries 5 tons, two trucks and a locomotive constituting an ordinary train. The locomotive is provided with two 25-horse-power motives; the total weight of a train is 20 tons, of which 10 tons is dead. Under favourable conditions four waggons may be taken in one train, making a total of 34 tons, of which 14 is dead load. Current is supplied from a neighbouring station. The speed is about four miles an hour. The current consumed is about 15 to 20 amperes at 550 volts for the empty train and 30 amperes for the full load. This is an interesting example of the transport of fairly heavy loads over common roads by electric

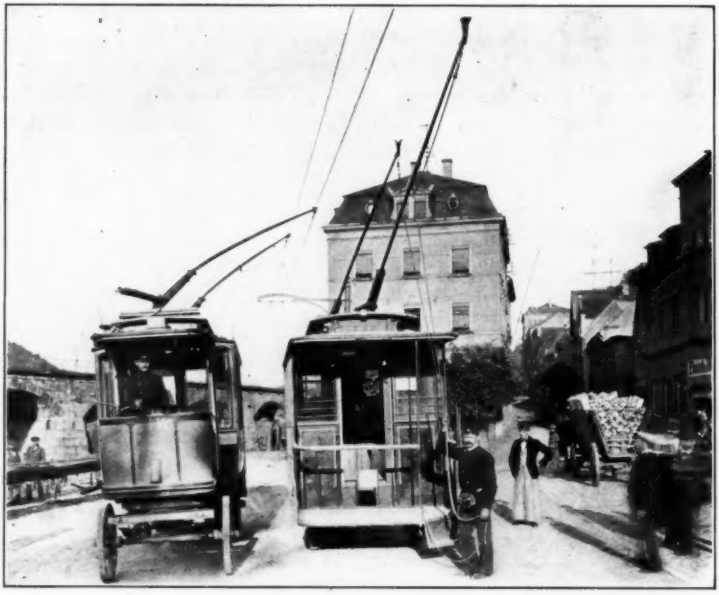


FIG. 13. TROLLEY OMNIBUSES, SIEMENS & HALSKE SYSTEM, TURNING OUT AND PASSING.

power. It is a new industry, of which we may have seen but the dawn; we may expect ere long to see its wide extension.

The short consideration we have been able to devote to the subject indicates, it seems to me, that electric traction by trolley and without rails presents great advantages over the use of accumulators, and in certain cases over that by trolley but upon rails. The problem is always complex, and no general solution is possible. Each case requires careful study to determine the bearing of the respective advantages and disadvantages. Electric traction by the overhead-trolley system, but upon the ordinary road surface, is at least in my opinion the sovereign method wherever the laying of rails is not practicable—but only pending the invention of the ideal storage battery. Then it will be the accumulator that will furnish the solution for the problems of traction in general and of electric traction in particular. No disturbance of the roadway, no *liaison* with the distant central station, no injury anywhere to the aesthetic.

RECENT DEVELOPMENTS OF THE STEAM TURBINE.

By A. Rateau.

As at present developed the steam turbine represents the work of many minds, from the aeolipile of Hero of Alexandria down to the most recently constructed machines. In the course of the growth which has converted the device from an interesting toy into a machine equalling, and in many respects surpassing, the reciprocating steam engine, M. Rateau has done much to assist in this remarkable progress, and he stands today as one of the notable figures in this department of steam engineering. A successful rotary steam engine has long been sought, and the solution of the problem has been deemed impossible by many able engineers, but in the steam turbine the question appears to have been solved, and in this solution M. Rateau has given material aid.—THE EDITORS.

OR several years the steam turbine has made a rapid industrial development, receiving numerous improvements which have placed it in a position to enter into an effective competition with steam engines of the reciprocating piston type, so that the turbine may confidently be expected to replace the ordinary forms of steam engine in many applications.

At the present time the results which have been obtained with the steam turbine are sufficiently high, from an economical point of view, to render them comparable with the best examples of triple-expansion reciprocating engines. For certain applications, indeed, the turbine possesses notable points of superiority over the piston type of engine, including all the inherent advantages of engines of continuous high rotative speed, such motors enabling a material reduction in the dimensions of the dynamos, alternators, fans, or centrifugal pumps to which they may be connected. In addition to this point it is hardly necessary to mention the well-known advantages included in economy of space, simplicity of construction, ease of operation, small consumption of lubricant, etc., etc.

Steam turbines form a portion of the class of machines to which the name of "turbo-machines" has been given, there being grouped under this title all the various machines which act upon fluids by means of one or more enclosed revolving wheels. In this class are included turbines and similar water-wheels, atmospheric turbines and windmills, centrifugal and helicoidal fan blowers, centrifugal and

helicoidal pumps, steam turbines, and propelling screws for boats and for aeronautical machines.

A steam turbine consists essentially of a distributing portion or portions, so arranged as to direct the steam obliquely against the revolving wheel, and of a wheel, or number of wheels, to receive the impulses of the jets of steam.

According as the path of the fluid remains at a constant distance from the axis of rotation, or is directed in a plane perpendicular to the axis, we have an axial or a radial turbine. Radial turbines are centrifugal if the fluid moves away from the axis, or centripetal if it moves towards the axis. At the present time almost all the turbines in use are of the axial type, since this form presents much greater facility for construction than the radial types.

Considered from the point of view of the action of the steam, we may consider: turbines of *action* (impulse turbines), and turbines of *reaction*. The first class, or impulse turbines, are characterised by the fact that for each group, consisting of a distributor and its corresponding revolving wheel, the steam is expanded entirely in the distributor, acting upon the wheel by virtue of the velocity which it has thus acquired. In the case of the reaction furbines, on the contrary, the expansion is only commenced in the distributor, and is completed in the revolving wheel. These two modes of action of the steam include interesting practical consequences.

In the first place, in a reaction turbine each wheel is subjected to different pressures upon its two faces; hence there results a longitudinal thrust which it is necessary to resist by the employment of balancing pistons. This difference in pressure tends to cause leakages of steam by reason of the clearance and play which exists between the fixed and the moving parts; hence it becomes necessary to reduce this clearance to a minimum, thus introducing certain difficulties in construction. This inconvenience does not exist in the case of the impulse turbine, and hence no balancing pistons are necessary, and a greater clearance may be permitted between the fixed and the moving parts.

The motor couple produced by the discharge of a fluid current upon the revolving wheel of a turbine may be calculated, as shown by the writer in his treatise on "Turbo-Machines," *(Revue de Mécanique*—July, 1897) by the formula:

$$C = \frac{I}{g}(r_0 a_0 - r_2 a_1)$$

in which:

I = the weight of fluid discharged through the wheel.

r_0, and r_2 = radii at the points of entrance and discharge,

a_0, and a_1 = the projections of the velocities of the fluid upon entering and upon leaving the wheel upon the velocity of its motion.

We shall not here discuss further the details of the theory, as it requires an extensive development for proper treatment, but proceed rather to a description of the actual operative types of the steam turbine, with some of the more important results which have been obtained. In order to simplify this examination we shall divide the machines in practical use at the present time into two classes, according as the rotating member is composed of one or of several wheels.

The first class, employing but a single wheel, contains two machines, the turbine of de Laval, and the machine of the Pelton type, designed by the writer.

The de Laval turbine is sufficiently well-known at the present time to require no detailed description. It is a pure impulse wheel, the buckets, numbering about two hundred, being fixed in the rim of a steel disc, this latter being made in the form of a solid of revolution of uniform resistance. The distributor consists of lateral nozzles, variable in number, and capable of being closed independently of each other. This turbine, like others containing but a single wheel, attains very high rotative speeds, necessitating the use of reduction gearing in the transmission. This is one cause of reduction in the efficiency, to which must be added the loss due to the fact that the steam, at the moment when it strikes the buckets, has a velocity about four times the peripheral velocity of the wheel, even when the latter is revolving at the maximum speed permitted by the resistance of its materials; while, for the maximum efficiency, the peripheral velocity should be a little less than one-half that of the steam.

In the single-wheel turbine designed by the writer the disc is made of a special piece of forged steel. The buckets, instead of being attached to the rim of the disc, are milled out of the solid metal of the rim, their form being that of the Greek letter omega, formed of two circular arcs, as shown in Figure 1. The buckets are short and thick, and consequently are of great strength, so that up to the present time there has been no instance of rupture. The steam is directed against the wheel by suitable jets, and being divided by the central fins, is discharged in two currents into lateral exhaust passages from which it escapes by a single exhaust pipe. The discharge of steam through the nozzle is regulated by a needle valve, controlled by a wheel and screw.

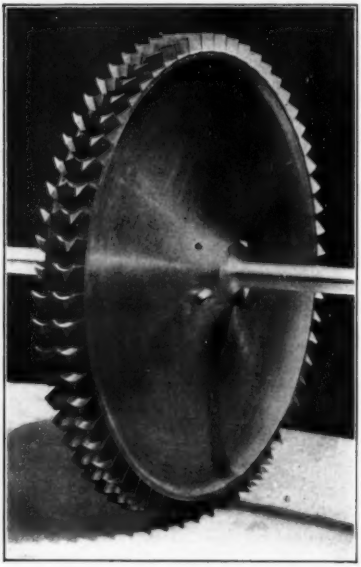


FIG. I. RATEAU SINGLE-WHEEL TURBINE.

The rotative speeds of this turbine are necessarily very high, so that it becomes necessary to employ speed-reduction gearing; double spiral gears are used, similar to those found in the de Laval turbine, and in conformity with the suggestion of the writer in a communication to the *Société de l'Industrie Minérale à Saint Etienne,* in 1890.

The efficiency of these turbines, although fairly satisfactory, is distinctly inferior to that of turbines of the multiple-wheel type, of which we shall now proceed to speak. Among the multiple-wheel turbines we shall mention the Parsons turbine, the Curtis turbine, and the Rateau turbine.

The Parsons turbine has been the subject of numerous articles and its general construction is so well-known that it is hardly necessary to describe it anew. It belongs to the reaction system, and is the practical realisation, with the perfecting of many interesting details, of the idea set forth by the French engineer Tournaire, as long ago as 1853.*

As this is a reaction turbine there exists a longitudinal thrust which it is necessary to oppose by compensating pistons, and in order to avoid injurious losses from leakage, the clearance spaces between the fixed and moving portions must be reduced to an extremely small amount, this involving a high degree of precision in the construction.

The Curtis turbine, an American invention, has recently been described in the technical journals; it belongs to the impulse class, and is peculiar in having a vertical axis.

The Rateau multicellular turbine, the result of an especial study of the subject by the writer, was briefly described in 1900, in a report presented by him upon the subject of steam turbines at the International Congress of Applied Mechanics at Paris in July 1900. In de-

* Comptes Rendus de l'Academie des Sciences, 28 Mars, 1853. Dictionnaire des Arts et Manufactures de Laboulaye, 1877.

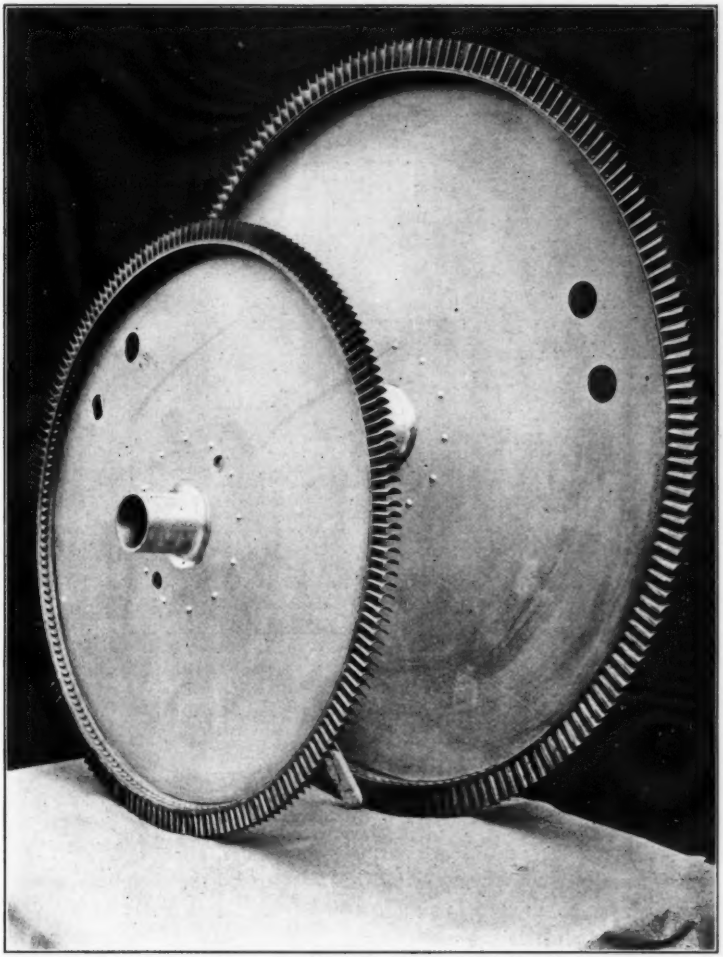


FIG. 2. REVOLVING WHEELS OF RATEAU MULTICELLULAR TURBINE.

signing this machine it was sought to satisfy the following conditions:

1. The attainment of a high mechanical efficiency, together with as low an angular velocity as possible;
2. The provision of a large, and at the same time non-injurious clearance between the fixed and the moving parts;
3. The attainment of the least possible weight of the whole machine, and especially of the rotating parts.

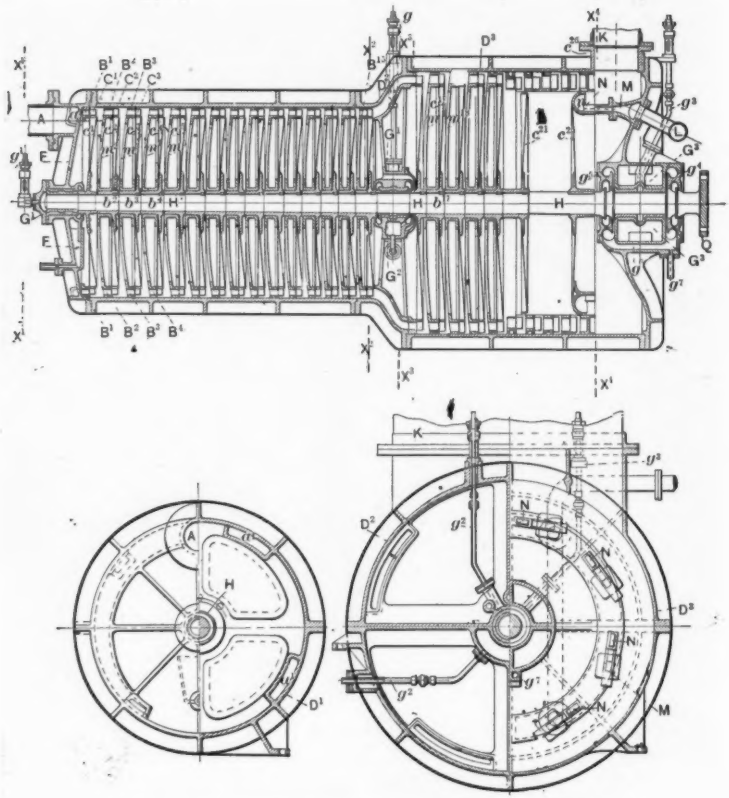


FIG. 3. THE RATEAU MULTICELLULAR STEAM TURBINE.

The revolving wheels are formed of discs of thin sheet steel, as shown in Figure 2, carrying cylindrical buckets on the periphery, these buckets being rivetted to a band of steel welded to the disc. This gives a very light and strong construction, maintaining its balance at all speeds. The guide buckets are fixed in circular diaphragms, secured at the periphery in grooves cut in the interior of the turbine case. There is thus left between the successive diaphragms a series of annular chambers in which the revolving wheels are placed, Figure 3. The shaft passes through bushings fitted in the diaphragms, there being but little play or clearance. Between the fixed and revolving portions of the turbine, however, the clearance may readily be made as much as 5

or 6 millimetres, without injury. The main bearings of the shaft are generally outside of the casing, a special form of stuffing box being employed, assuring tightness against leakage. The external appearance of the machine is shown in Figure 4.

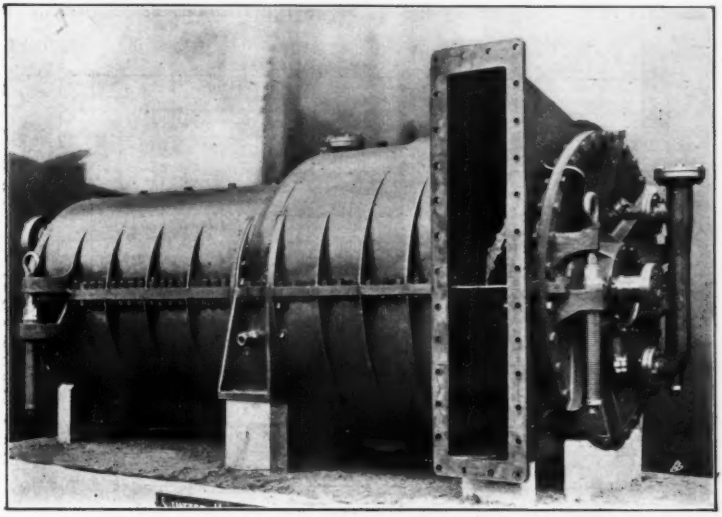


FIG. 4. EXTERNAL VIEW OF THE MULTICELLULAR TURBINE.

An ordinary compensated centrifugal governor is used to regulate the speed, acting by varying the pressure of the steam delivered to the turbine. By means of a by-pass in the main steam pipe it is possible to deliver steam of full pressure both to the entrance of the turbine and to a point in the machine nearer to the condenser, this enabling a higher power than the normal amount to be produced by the machine, much in the same manner as a compound engine may be used with full pressure steam in both high and low-pressure cylinders.

I shall now proceed to justify my statements in regard to the efficiency of the steam turbine by giving some data and results of actual tests. It will be understood that the efficiency will be computed by taking the ratio between the theoretical consumption of an assumed perfect engine and the actual consumption of the engine under consideration; both being referred to the net power delivered at the engine shaft, or better, to the electrical power at the terminals of the generator, when a generating set is under consideration. The theoretical consumption will be taken as that which corresponds to the maximum amount of work of which the steam is capable at the condition

(saturated or superheated) in which it is delivered to the engine, expanding from the higher to the lower pressure adiabatically and without loss. The laborious calculations which would otherwise be necessary in making this computation may be dispensed with by using the diagram first published by the writer in the *Annales des Mines,* and here given in Figure 5.

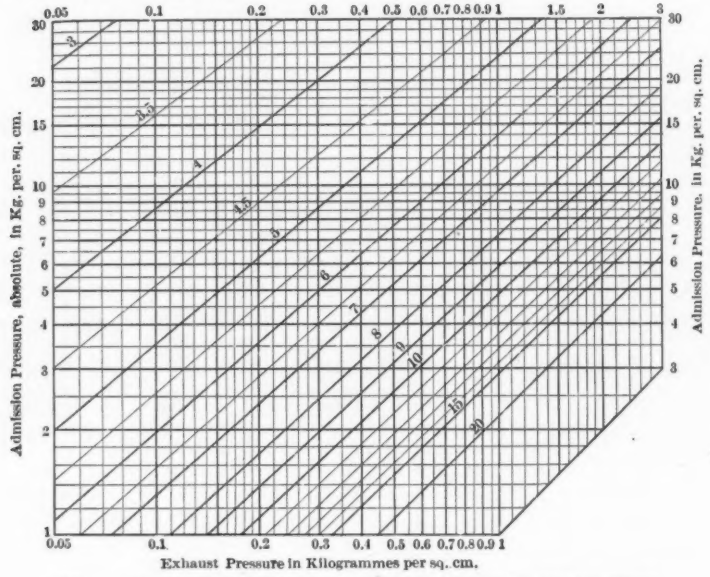


FIG. 5. DIAGRAM FOR COMPUTING THEORETICAL STEAM CONSUMPTION.

One of the most important trials which has been made of the Parsons' turbine is that upon the machine at Elberfeld, this being a generating set of 1,200 kilowatts, tested by Messrs. Lindley, Weber and Schröter. The following table is taken from their report:

Test of Parsons' Turbine at Elberfeld.	Metric units.	British units.
Initial pressure, mean*	7.81 kg. cm.^{2}	110 lb. sq. in.
Exhaust pressure	0.063 "	8 " "
Superheat	21° C.	38° F.
Load on generator	1,190 kw.	
Revolutions per minute	1,480	
Steam consumption per k.w. hour observed	8.81 kg.	19.5 lb.
Steam consumption, theoretical, incl. superheat	5.05 kg.	11.2 "
Efficiency of generating set	0.573	

* The mean initial pressure was the average of the extreme values of the oscillations produced by the action of the admission valve.

I will now give the data and results of a test of a Rateau turbine of 500 horse power, forming a portion of a group of three machines driving continuous-current dynamos at the central station of the Peñarroya mines in Spain, and constructed by MM. Sautter, Harlé & Cie., of Paris.

TEST OF RATEAU TURBINE AT PEÑARROYA.

Data.	¼ Load.	½ Load.	Full load.	Overload.	Overload at 2,400 rev.
Electrical h. p. at brushes	135	259	525	627	641
Admission presence, absolute, kg. per cm.^{2}	3.25	5.4	9.6	11.00	11.9
Exhaust pressure, absolute, kg. per cm.^{2}.	0.0877	0.094	0.115	0.128	0.128
Theoretical steam consumption of perfect engine per h. p. hour.....	4.95	4.43	4.00	3.95	3.95
Actual steam consumption per electrical h. p. hour, at brushes.....	9.66	8.16	7.14	6.95	6.74
Global efficiency of the electrical generating set	0.513	0.540	0.560	0.569	0.580

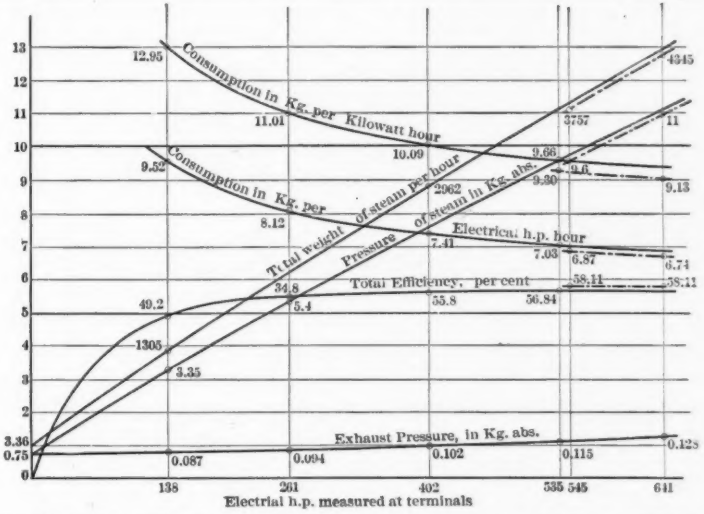


FIG. 6. CURVES SHOWING PRESSURES AND PERFORMANCES OF A 500 H. P. GENERATING SET, RUNNING AT 2,400 REV. PER MIN.

It will be seen from this table that the steam consumption per electrical horse-power hour fell as low as 6.74 kilogrammes, or 14.9 pounds, a very low figure for a machine of this size. The "global" efficiency, that is to say, the combined efficiency of the turbine and the

TEST OF RATEAU TURBINE AT THE BRUAY MINES.

Rev. n	Volts. V	Amp. A	K.W. at terminals.	Elec. H. P. at terminals.	Absolute Pressures. Admission.	Absolute Pressures. Exhaust.	Temp. of steam. t°	Vol. of steam measured.	Steam Consumption. Measured. K	Steam Consumption. Theoretical. K	Global Efficiency. *
1690	495	385	190.5	259	0.845	0.156	132°	4660	18.0	10.05	0.559
1830	503	392	197.5	268.5	0.845	0.156	132°	4660	17.4	10.05	0.578
1840	503	393	198	269	0.845	0.156	133°	4660	17.3	10.05	0.581
1605	500	465	232.5	316	1.01	0.177	135°	5700	18.05	9.65	0.534
1700	510	472	240.5	327	1.01	0.181	135°	5700	17.45	9.75	0.559
1800	515	480	247	336	1.01	0.184	135°	5700	16.95	9.85	0.580
1610	Running empty—not excited.				0.136	0.087	111.6°	—	—	—	0
1600	506.7	278.1	140.9	191.7	0.659	0.128	135°	3693	19.1	10.1	0.530
1591	505.6	399.6	202	275	0.902	0.163	137°	5010	18.0	9.56	0.531
1598	503.2	462.1	232.5	316.5	1.034	0.196	147°	5736	17.9	9.92	0.556

During the above trials the barometric pressure was 755 mm. for the first 6 tests, 760.5 mm. for the 2 following, and 759 mm. for the last two.

* The "global" efficiency corresponds to the ratio of the electric energy, measured at the terminals of the dynamo, to the energy theoretically contained in the flow of steam received: this efficiency being determined after deducting all the losses due both to the turbine and the dynamo.

dynamo, reaches 59 per cent. The diagram, Figure 6., shows the variation in steam consumption per electrical horse power and per kilowatt, and that of the global efficiency of the turbine-dynamo as a function of the power developed. Upon examining this diagram one is struck immediately with a peculiar feature. The curve representing the steam consumption is practically a straight line, the ordinate at the origin being very small, showing that the steam consumption is almost exactly proportional to the power developed, except for very light loads. The steam consumption when running without load, the dynamo being excited, is about 10 per cent. of that at full load. For a reciprocating engine, under the same conditions, the steam consumption when running without load and with the dynamo excited, is from 15 to 25 per cent. of the consumption at full load.

A number of machines of this type have been built and others are under construction. Referring to some of the more important ones, we may mention: a turbo-alternator of 1,000 horse power, installed in the works of MM. Sautter-Harlé & Co., at Paris; a turbo-dynamo set of 540 horse power at the Huta-Bankowa Iron Works, Russia; a turbo-alternator of 400 horse power for the Société Electrique de la Loire; a turbine-dynamo of 600 horse power for the Ateliers de Rüschlikon, Switzerland, and two of 1,500 horse power, one for the power plant at La Goule, Jura, Switzerland, and the other for the works at Rheinfelden, Baden, these last three machines having been constructed by the Oerlikon Works, near Zürich.

The table on page 58 gives data and results of trials made of a low-pressure turbine of 300 horse power at the Bruay mines, Pas de Calais.

The interesting feature about these figures is the manner in which they show the very economical use of very low-pressure steam.

It will be seen that the efficiency is even slightly higher than that obtained with high-pressure steam, while in the case of reciprocating engines the results with low-pressure steam are very bad. In addition to the poor economy with low pressures, a reciprocating engine would have to be made with cylinders of very large size, thus adding difficulties in connection with first cost and with erection and space.

This interesting property of the steam turbine, permitting it to be operated to advantage with very low-pressure steam, has suggested to me a method of employing it to utilise the exhaust steam of high-pressure reciprocating engines, such as are in use in mines, rolling mills, etc. For this purpose I have designed a regenerative accumulator which converts the intermittent discharge of the exhaust steam into a continuous flow, suitable for use in the turbine. In this way

the primary engine obtains all the benefit due to the use of a condenser, and an important economy is effected. This plan has been put into practical operation at the Bruay mines, the exhaust steam from one of the winding engines being used to operate a turbine of 250 horse power. A similar, but more important installation, including two turbo-generating sets of 650 horse power, is under construction for the Reunion mines, in Spain.

In addition to the use of the steam turbine for driving electric generators, it has been found especially well adapted for operating centrifugal pumps and fan blowers. The high rotative speeds obtainable render it practicable to construct pumps of large capacity and to make fan blowers capable of producing much higher pressures than have heretofore been possible with such apparatus.

Thus, for example, a turbo-pump of the Rateau system, built by MM. Sautter-Harlé & Cie., in which the pump wheel is only 8 centimetres in diameter, delivers 12 litres per second to a height of 263 metres, making 18,000 revolutions per minute, and giving a mechanical efficiency of about 60 per cent. Another arrangement is that of the multicellular centrifugal pump, which permits the elevation of a continuous stream of water to a great height, while employing much lower rotative speeds than the preceding, and having an efficiency altogether comparable to that of a piston pump. An example of a pump of this kind is seen in Figure 7, which represents a multicellular centrifugal pump and turbine in operation at the Falkenau mines in Bohemia, elevating 3 cubic metres of water per minute to a height of 212 metres, operating at 3,200 revolutions per minute. The steam consumption of this set is 12.5 kilogrammes per horse power, based on the effective work delivered in the quantity of water elevated. The steam pressure at admission is 7.30 kilogrammes per square centimetre (absolute) and the exhaust, 0.174 kilogrammes. With a better vacuum, which might readily be obtained, this performance would be improved. The total efficiency of pump and turbine is 36 per cent., which corresponds to an efficiency of about 65 per cent. for the pump and 54 per cent. for the turbine. There is under construction at the works of MM. Sautter-Harlé & Cie., a multicellular turbo-pump for the Bruay mines to elevate a continuous jet of 250 cubic metres per hour to a height of 360 metres, corresponding to a net effective work of 335 horse power. The guaranteed steam consumption, including the resistance of the air pump, is only 10.5 kilogrammes.

Turbo-fans are comparable in all points to turbo-pumps. Even with a single wheel very good results have been obtained, giving pres-

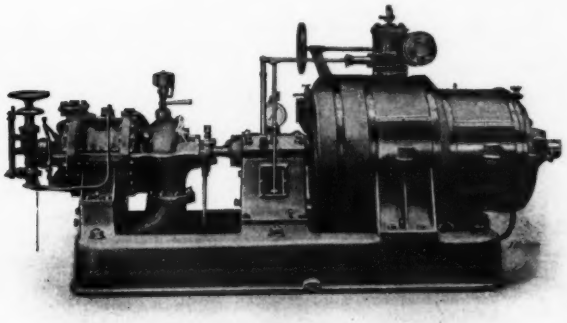


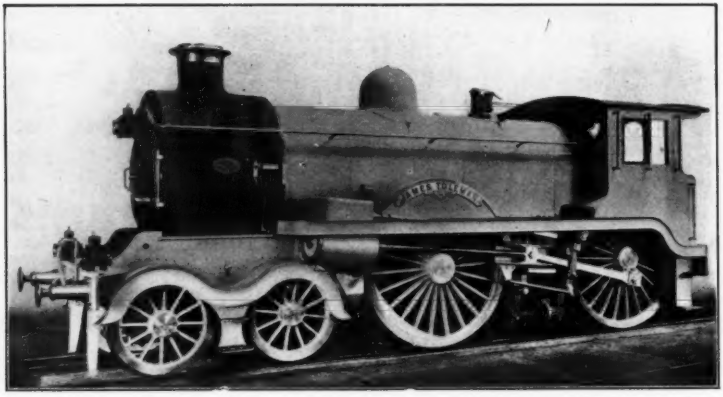
FIG. 7. MULTICELLULAR CENTRIFUGAL TURBO-PUMP.

sures up to 6 metres of water. A turbo-fan in which the wheel is only 25 centimetres in diameter, running at 20,000 revolutions per minute, has delivered 0.7 cubic metre of air per second at a pressure of 5.50 metres of water, with a mechanical efficiency of about 60 per cent. MM. Sautter-Harlé & Cie. have constructed a turbo-blower for blast furnace service, for the Chatillon-Commentry Works, which, with a wheel of 30 centimetres in diameter, delivers 2.5 cubic metres of air per second at a pressure of 2.50 metres of water. Similar blowers have been made for the French navy and for the British Admiralty.

Turbo-compressors of the multicellular type possess material advantages over the ordinary piston type, especially with regard to the small space required for the installation of a machine of large capacity. In general, this is one of the most important advantages of the steam turbine and of all its numerous applications.

The brilliant applications of the turbine to navigation which have been made by the Hon. C. A. Parsons are well-known. The first trials, made in 1894 with the Turbinia, showed the possibilities of the system, and since that time a number of turbine propelled boats have been constructed, including the torpedo destroyers Viper, Cobra and Velox, the passenger steamers King Edward and Queen Alexandria, the yachts Tarantula, Lorena, Emerald, and others. The writer has also made plans for turbine machinery for two torpedo boats for the Fench navy, but owing to delays which have no connection with the machinery, these have not yet been put into service.

The future of the steam turbine now seems to be fully assured, and the day appears to be approaching when it will supersede the older type of reciprocating engine, at least for a great portion of its applications.



The "James Toleman"—Winby's Express Engine with Specially Designed Boiler.

SPECIAL FEATURES IN THE DESIGN OF LOCOMOTIVE BOILERS AND FIREBOXES.

By Chas. S. Lake.

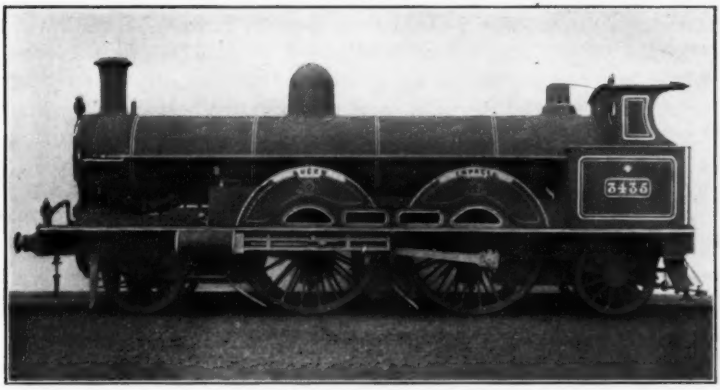
Locomotive boiler practice shows, in most advanced and striking manner, the results of the tendency apparent everywhere in steam engineering—the rising demand for increased steaming power within very limited space and dimensions. This gives a broad scope of application and interest to the discussion which Mr. Lake opens in this number and will continue in November and December. And the first two sections dealing with British types are of especial importance because the limits of the loading gauge there have forced designers to the utmost of ingenuity and effort to attain the necessary ends.—THE EDITORS.

ONE of the most important considerations which the locomotive engineers of the present day have to take into account, is that of providing the engines which they design with boilers capable of generating and maintaining a sufficient supply of steam to meet all probable requirements and possible emergencies which may arise under the varying conditions which attend the everyday working of heavy and fast traffic, such as is to be found upon all the larger and more important railway systems of the world.

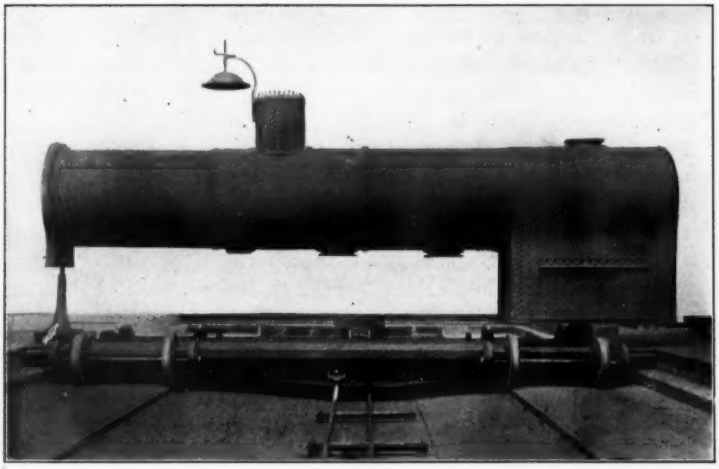
The tendency which is prevalent nowadays to increase cylinder proportions continually in order that greater power may be obtained, has rendered the employment of large boilers and fireboxes (containing all the heating surface area which it is possible to confine within the available limits) absolutely indispensable if ultimate success is to be ensured; but the bare fact that a locomotive is possessed of what ap-

pears at first sight to be an ample allowance in this respect must not, by any means, be taken as indicative of the superiority of that particular engine over others of similar general design, in which an imposingly large amount of heating surface is not the predominating feature.

A fair proportion of the total number of tubular square feet is very often only *nominally* of value for the purpose of rapidly evaporating water; indeed, one eminent engineer has gone so far as to say that—in his opinion—it is only for the first foot or so from the firebox end that the tubes may be reckoned upon as capable of producing steam at high pressure and in abundant quantities, and beyond that distance they are more or less inadequate for the purpose for which they are intended. This view, although it will not perhaps be generally endorsed by engineers as a body, is in itself substantially correct. It is, beyond question, an established fact that one of the chief reasons why boilers with elongated barrels are not more frequently resorted to as a means of securing a greater amount of heating surface is, that the added length of the tubes does not result in any material gain in so far as *effective* area is concerned, but merely represents on paper that which is not fulfilled under actual working conditions. The American expedient of coned boilers has recently been introduced on the Great Western Railway of England. The plan has unquestionable advantages, as it provides additional cubic space for steam-raising purposes in the immediate vicinity of the firebox. The statement which has appeared elsewhere to the effect that by means of the coned ring a larger



THE "QUEEN EMPRESS," 3-CYLINDER COMPOUND EXPRESS LOCOMOTIVE.
F. W. Webb's system, fitted with combustion-chamber boiler.



BOILER OF "GREATER BRITAIN" CLASS OF LOCOMOTIVES, LONDON & NORTHWESTERN RAILWAY.

F. W. Webb's system, 3-cylinder compound.

amount of *heating-surface* area is obtained is manifestly an absurd one. No increase in the number of tubes or their diameter is rendered possible by the use of the coned pattern boiler, therefore the augmented heating surface claimed by one writer on the subject is wholly an imaginary one.

When Mr. Webb was introducing his "Greater Britain" class of three-cylinder compound locomotives upon the L. & N. W. Railway in 1891, he adopted the unusual figures of 18 feet 6 inches for the length of the boiler barrel, but he recognised the fact that only a percentage of the total span of the tubes would be operatively efficient for heating purposes, and he consequently divided them into two groups separated by a combustion chamber, which arrangement is illustrated by Figures 2 and 3 and will be described later.

In 1895 Mr. Aspinall, the then locomotive superintendent of the Lancashire and Yorkshire Railway, furnished the Railway Congress assembled at that time, with a report upon the subject of Express Locomotives. Commenting upon this report in a leading article the *Engineer* said:—

> "Tube surface may be augmented reasonably by adding to the length of the tubes, but although increased tube surface promotes economy of fuel by increasing the quantity of water evaporated per pound of coal, it only very slightly augments the actual efficiency of the boiler.

> "Given the same grate and fire-box in two engines, one with 1,000 feet and the other with 1,200 feet of tube surface, the steaming powers of the two boilers will be pretty much the same, but the economic efficiency of the latter will be a little greater than that of the former."

These remarks bear out the contention advanced against the employment of exceptionally long tubes.

It is only during comparatively recent years that the need for enhanced steam-producing powers in locomotive boilers has been so urgently felt as it is at the present time. As a natural outcome of railway traffic developments, a demand has sprung into existence, not only for *more* locomotives, but for individual machines capable of performing, without assistance, the work previously allotted to two engines. It is necessary to provide cylinders of 19 or even 20 inches in diameter to accomplish satisfactorily the work of hauling modern heavily weighted trains, and anyone who is in possession of even the most rudimentary knowledge of the subject will easily perceive that if the maximum advantage is to be obtained from the employment of such dimensions, it is essential that a plentiful supply of steam at a high working pressure should be continuously available.

Those who have not given much time or attention to the subject are apt to conclude that there should, after all, be no great difficulty in arranging for an adequately proportioned area of heating surface, and base their opinions upon the hypothetical understanding that all it is necessary to do is to increase the diameter of the boiler and add to its length and so, *nolens volens*, the desired object can be at once attained. It is impossible to proceed very far upon such lines as these, however, before obstacles are encountered which clearly demonstrate to the practical mind the futility of adopting such methods as a means of overcoming the difficulty.

Express locomotives are, as a rule, provided with driving wheels varying between 6 feet 6 inches and 7 feet in diameter, and the boiler must be restricted to such proportions as will allow of its barrel being placed partially *between* and not wholly *above* them, as may be done with engines having wheels of small diameter. Then, over and beyond the reason given for not utilising tubes of great length (on account of their unsuitability for providing really effective heating surface except throughout a percentage of their length), there are considerations of space to be taken into account, as it must not be forgotten that an extension of wheel base follows any material lengthening of the boiler, and the serious expense which would be involved in altering existing turntables to accommodate any new design of engine is a very

powerful determining factor against such a policy being generally adopted.

All these matters are engaging the very closest attention of the responsible authorities at the present time, and it is becoming increasingly evident that the direction in which the majority of them are looking for a solution of the difficulty is that of the possibilities of introducing special steam-raising appliances and devices, rather than to the development of what may be termed the "standard" type of boiler and firebox, with which finality has nearly been reached, owing to loading-gauge limits and other considerations of a like nature. It is with a view to presenting a collective survey of the widely different methods which are being employed in various countries and by engineers of sundry nationalities that the author has prepared the present article; but before passing on to a detailed description of the particular examples which have been selected for illustrating the subject in hand, a few words upon the question of the relative merits of different metals for certain specified purposes may perhaps be of interest to the majority of the readers of these lines.

Opinions vary in a marked degree upon this branch of the subject. Practice and theory also are, as usual, found to be at variance upon some of the most vital points. Many engineers favour the use of steel for boiler plates and the outer shells of fireboxes, but an equal, if not a larger, number advocate the employment of the best Yorkshire (Low Moor) iron as being superior for the purpose. One of the foremost believers in the first-named material is Mr. F. W. Webb, who constructed steel boilers at Crewe for a number of years.

The practice of so doing is becoming more general as time goes on, and from all appearances is likely to become almost if not quite as common a feature of British, as it already is of American locomotive construction.

Steel has a much higher tensile strength than is possessed by iron, the average being 26 tons to the square inch, which, with an elongation of 25 per cent. in 8 inches, represents 18 per cent. more resistance and twice the elongation that can be claimed for the latter material. As a consequence of these advantages it is possible to use thinner plates where steel is employed than would be deemed advisable in the case of iron. Another advantage which may be mentioned is the greater amount of ductility possessed by steel of good quality, which renders it more suitable for flanging than iron.

For "inner" fireboxes however, there can be no question but that copper is the best possible material that has up to the present been

tried. It is vastly superior as a conductor of heat, is better capable of withstanding any sudden strains to which it may be subjected, without sustaining injury, and is, of course, an easier metal to "work," thereby greatly facilitating manufacturing processes. On the other hand it is more expensive as to first cost, and there are times when copper in sufficient quantities and of the high standard required is not available even at what are known as "standing average" prices. As regards British practice, however, its use is almost universal for the purpose, but in some other countries—especially the United States—steel is largely employed in the construction of fireboxes.

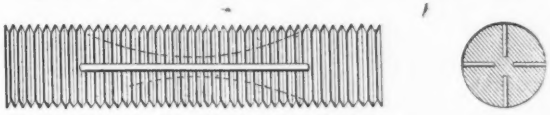


FIG. I. FLEXIBLE FIREBOX STAY.
Designed by Stone & Co.

Coming next to the question of the most suitable material for firebox stays (a most important point) we find a growing inclination to resort to bronze or copper alloys in place of copper alone. Here again the element of prime cost enters into the arguments, but I for one cannot help thinking that only copper—and that of the best obtainable quality—should be used for these stay bolts, and further, in my opinion, they should have a larger diameter than the usual 1 inch which is the average size employed. If the stay bolts were made 1½ inches in diameter and spaced at 4½ inches apart the risk of their fracturing, either in the body or in the plate, would be greatly reduced. A water space of 3 inches is very desirable, but it is difficult to arrange this under existing conditions and the usual figure is 2½ or 2¾ inches.

Hollow stay bolts are by no means uncommon upon the Continent and in the States and have met with some success. They are usually made either of copper or an admixture of that and other metals. Messrs. Stone & Co., a firm of engineers who make a specialty of these articles of manufacture, have brought out a flexible stay provided with four longitudinal slits extending for about two-thirds of its length. These slits are cut into the body of the bolt, to within about ⅛ inch of the centre, the resultant section being as shown in the illustration Figure 1. These stay bolts are said to be capable of withstanding thirty times as many strains as are those of the ordinary pattern.

With regard to the tubes, we find an equal diversity of opinion. Copper and brass undoubtedly possess some advantages over iron and steel for this purpose, but, all things considered, the extent of super-

iority possessed by the former metals over the latter is not very easily defined. Brass is considered by some to be the best material of all in the long run for tubes. It costs less than copper, is a very good conductor of heat, and has proved itself to be remarkably durable.

A composite material known as "red metal," consisting largely of copper, is frequently used in Great Britain and in Continental countries, as are also various combinations of copper and other metals in an alloyed state, but in America the vast majority of engineers favour iron for tubes and steel for fireboxes.

As illustrating the great difference of opinion which exists between engineers on either side of the Atlantic upon this matter a case in point may be quoted:—

During the year 1901 the American Locomotive Company built an engine at their Richmond Works for the New Zealand Government Railways, and in the course of a descriptive article upon this locomotive which appeared in the columns of one of the most important American engineering journals, the following passage occurred.

"There is, said the writer, one fad that the British and the British Colonies have hung to very persistently in engines built for them in America—that is, the firebox must be of copper and the tubes of copper or brass. In this engine the firebox is of steel, and the tubes are iron." It was also stated that the engine was built as a "sample" and was "another instance on the part of our English friends to take the pure and simple American locomotive instead of the hybrid which it was the custom to specify a few years ago." Many other extracts of a similar character could be culled from the columns of the American engineering press, and they go to emphasise the fact that American locomotive men are equally as decided in their opinion, that steel and iron are more suitable than copper or brass in the construction of fireboxes and boiler tubes, as engineers in England are in believing the opposite to be the case.

Having thus far digressed from the main topic under consideration it will be necessary, in the interests of space, to enter at once upon a discussion of the principal examples of special boilers and fireboxes which are being, or during recent years have been, tried with the object of increasing the general efficiency of the locomotives to which they have been adapted. Mr. Webb's "Greater Britain" type of boiler (to which reference has already been made) was designed at a time when the necessity for constructing some locomotives of even greater power than those already possessed by the London and North Western Railway Company at that period, was making itself felt.

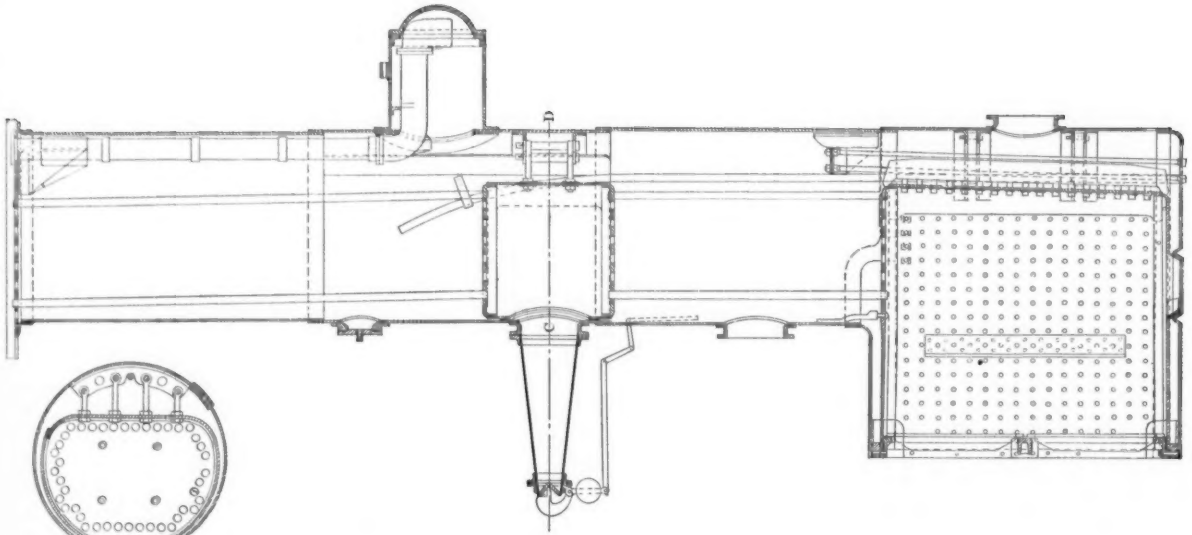
The three-cylinder compound system was adhered to and the principal dimensions of the express engines knows as the "Teutonic" class, which immediately preceded those under notice, were retained; but an additional pair of carrying wheels were placed behind the firebox and the high-pressure driving wheels were advanced so as to come immediately in front of it, thus making it necessary to adopt a much longer boiler barrel than had been used in any other engines in existence up to that time upon the London and North Western Railway.

Being of opinion that it would be of advantage if some special method of more effectively heating those portions of the tubes furthest removed from the firebox were introduced, Mr. Webb provided an intermediate combustion chamber which, as is shown in the drawing (Figure 2) is situated in such a position in the barrel of the boiler that the hopper which is attached to it is clear of the low-pressure connecting-rod end when the piston is at the end of its stroke. To the bottom of this hopper an air-tight valve is fixed and is weighted in such a manner that in its normal position it is closed, but it is connected by rods to the foot plate, in order that the driver may be enabled to open it at will for the purpose of discharging the ashes which have accumulated.

The chamber is also fitted with a steam-blast apparatus for clearing the tubes of soot.

The manner in which the combustion chamber is constructed is clearly shown by Figures 2 and 3. It will be seen, by reference to those illustrations, that the body consists of one piece of plate so fashioned as to present a flat top for the purpose of facilitating direct staying, which is effected by means of eight eye bolts, the screwed ends of which pass through the flat roof already mentioned and are secured by nuts top and bottom, whilst the other ends are connected, by four cheese-headed long bolts, to two pieces of 4½ by 8¼ by 11/16 inch angle iron placed 11 5/16 inch apart, which in turn are rivetted to the inside of the boiler shell. The course followed by the plate forming the sides and bottom of the combustion chamber is a semicircular one, joined to the flat top by means of 7¾ inch radii and coming down to within half an inch or so of the bottom of the boiler barrel. The intervening space is occupied by a foundation ring of steel for strengthening the aperture which provides communication between the chamber and the hopper, and which is sufficently large to allow of the passage of a man's body through it.

As will be seen by the cross section (Figure 3) this method of construction does away with the necessity for more than one joint, and is



FIGS. 2 AND 3. SECTIONS THROUGH "GREATER BRITAIN" TYPE OF BOILER WITH COMBUSTION CHAMBER.

decidedly the best and most economical plan which could be employed. The combustion-chamber tube plates are made of copper ¾ inch in thickness, flanged inwardly and rivetted to the plate which forms the body.

The tubes, 150 in number, between the firebox and the combustion chamber, are of copper, 2⅛ inch diameter outside and 6 feet over all in length. They represent 506.2 square feet of heating surface, and it will be noticed that whilst they are fixed horizontally, those which are situated between the forward tube plate of the combustion chamber and the smokebox are inclined in a downward direction towards the smokebox, the total fall amounting to 6⅜ inches in the length of 10 feet 1 inch which separates the two tube plates.

These forward tubes, of which there are also 150, are of steel and provide 875.0 square feet of heating-surface area, which together with the 506.2 square feet of the rearmost tubes, the 39.1 square feet of the combustion chamber, and 120.6 square feet which is derived from the firebox, gives a grand total of 1540.9 square feet, an unusually large allowance at the time when the engines were built.

Writing to the author upon the subject of these boilers Mr. Webb says:—

> "My reason for using steel and copper tubes in the same boiler is, that copper tubes are more easily kept tight in the firebox tube plate than steel ones, but, as there is no difficulty in keeping steel tubes tight further away from the firebox where the heat is not so great I prefer to use them in that part of the boiler between the combustion chamber and smokebox."

The company possess ten locomotives of this class and ten others of similar general design but having driving wheels 6 feet in diameter. These latter engines are known as the "John Hick" class and are used for working north of Rugby exclusively. Both series have given satisfaction, but have now been superseded by Mr. Webb's extremely powerful four-cylinder engines, in which the ordinary type of boiler with a shorter barrel has been reverted to.

No article dealing with the subject set forth in the title of the present one could be considered as even approximately complete unless it contained reference to that remarkable specimen of locomotive—and especially boiler—construction which was designed in 1893 by Mr. F. C. Winby of London with the idea of demonstrating the lines upon which, in his opinion, the locomotives of the future should be built. It will not be necessary for present purposes to enter into the merits or demerits of the design as a whole. That was done at the time of the

appearance of the engine, as writers in nearly every engineering journal gave expression to more or less decided views upon the subject, some favourable and some otherwise but all voluminous in character.

Designed by an Englishman and constructed by a well-known firm of locomotive builders (Messrs. Hawthorn Leslie & Co. of Newcastle-on-Tyne) the engine was never destined to be given a trial in Great Britain but was shipped off to the States for the purposes of exhibition at the World's Fair at Chicago in 1893, where it was accorded a considerable amount of attention and criticism and was eventually tested upon the Chicago, Milwaukee and St. Paul railroad but unfortunately with only indifferent results. The principal contributory factor to this lack of success was the boiler, which as will be seen by the illustrations was of an entirely novel construction.

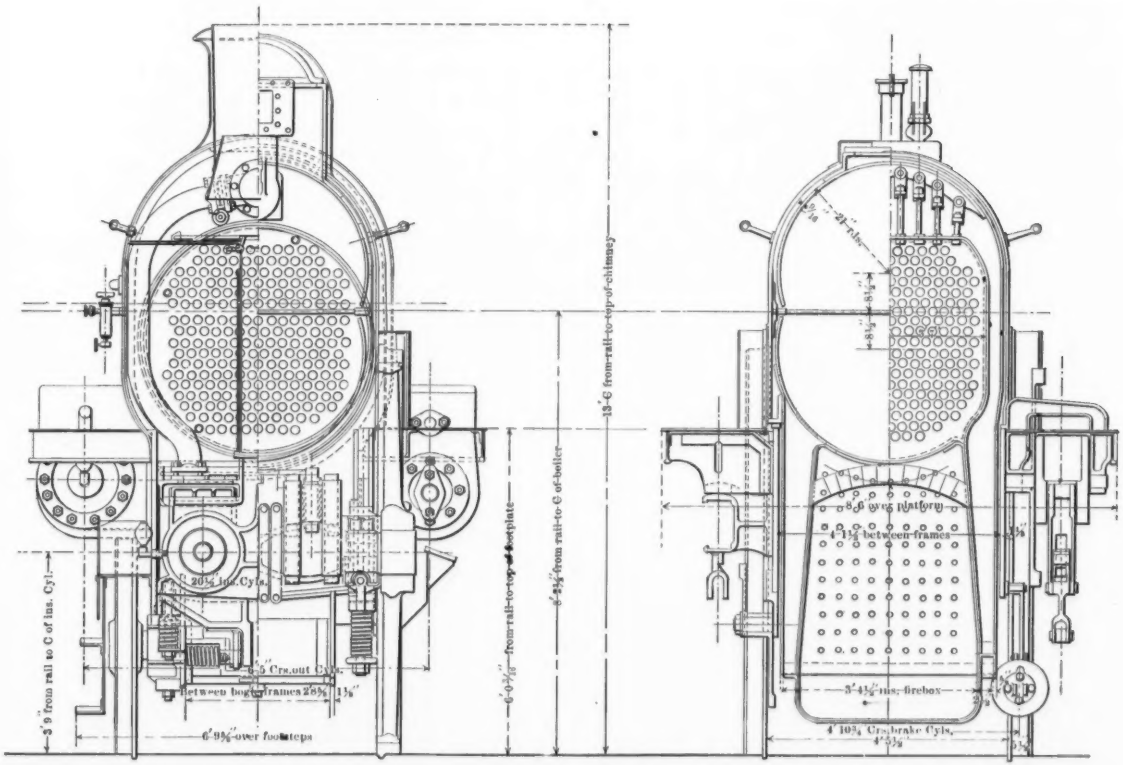
The designer aimed at providing a very large amount of heating-surface area in the tubes, and in order to accomplish this he adopted the idea of increasing them numerically as well as in length and he decided upon having 235 tubes of 2 inch diameter and 14 feet 9¼ inches in length, the resultant aggregate which he obtained from them alone being 1817.4 square feet. He found that to get a barrel of the customary cylindrical section, large enough to contain this great number of tubes, between the wheels (which were 7 feet 6 inches in diameter) would be a physical impossibility, and he therefore resolved upon utilising the unusual section shown in the cross sectional views Figures 4 and 5, which resembles as much as anything else two arches facing one another, and connected together by heavy butt straps.

A row of screw stays passing between the tubes, thus dividing them into two approximately equal groups, were used for uniting the two butt straps, these stays being pitched at very short centres with the object of providing resistance to the bursting stress which would have to be contended againt at this point.

The boiler barrel was quite moderate in length, being actually only 9 feet 2¼ inches, but the distance between the tube plates was no less than 14 feet 9¼ as stated. By referring to the longitudinal section (Figure 6) it will be seen that this was effected by means of carrying the smokebox tube plate partly into the smokebox, whilst the barrel of the boiler projected into the firebox; consequently, the grate extended beneath the boiler barrel for a length of a little over 5 feet.

The firebox was of copper, and to allow of the proper circulation of the water at its sides, slits were cut through the boiler plates where they projected into the firebox shell.

At the conclusion of the Exhibition the engine was put in steam and



FIGS. 4 AND 5. CROSS SECTIONS THROUGH BOILER AND FIREBOX OF WINBY'S EXPRESS LOCOMOTIVE.
By courtesy of *The Engineer*.

ran upon the Chicago, Milwaukee and St. Paul railroad as stated, without achieving much success. The boiler gave considerable trouble, some of the stays leaked, and it was only with difficulty that proper head of steam was maintained, which circumstance, together with the manifestation of other weak points in the design, resulted in the engine being taken out of service and "laid up" at Milwaukee for some few years. A final and permanent resting place has at length been found for it, the trustees of Purdue University having secured it for the purpose of instruction to the students attached to the engineering classes there.

Unstinted praise was bestowed upon the character of the workmanship displayed in the construction of the engine, and considerable sympathy for Mr. Winby was felt both in England and America at the failure of his boldly conceived design. At all events one useful purpose was served; the experiment disposed of many theories held by various persons concerning boiler construction, and cleared up many points upon which considerable doubt had been felt among those whose circumstances did not allow of an opportunity of their own ideas being put to the test.

There was unmistakeable evidence of a great amount of ingenuity having been brought to bear upon the designing of this locomotive, and it seems tolerably certain that had Mr. Winby been content to adhere to the ordinary type of boiler, his engine would have met with a very large measure of success.

Space limits prevent the completion of the study of British practice in this issue. It will be concluded in the following number, and a final paper will deal with American and Continental types.

THE ISSUES BETWEEN LABOR AND CAPITAL.

By Egbert P. Watson.

HAVING had a considerable experience with working men of many trades—at the vice and machine tools myself, and as an employer—I have been much interested in the present disorganized conditions whereby one working man's hand is raised against another, and all, or a very large portion are arrayed against employers. I have studied this aspect from all points that suggested themselves, in the hope of finding some solution which would be satisfactory to all concerned; but, as yet, I have not found any. Part of the trouble seems to lie in the great change in workingmen themselves in the last twenty years. Before that time, in the United States, at all events, they were free agents, chosing their own shops and employers, and, in the main, orderly, well-behaved, useful citizens. They did a fair days' work for fair wages, and employers dealt directly with each individual according to his merits. This system worked well, and there was no wide-spread dissatisfaction with it; but so soon as what is called organization became popular, trouble was experienced, and it has continued to this day. If American workmen were free to choose between allegiance to an employer and subservience to unions, with all their impositions and taxes, I believe, from observation and experience, that every union would be voted out of existence, and in saying this I am well aware of associations which have even arrayed themselves against the government, and are endeavoring to fix rules and regulations under which they will continue in the public service (the mail-carriers' association is one of them) but press reports do not express the opinions of the rank and file, only the utterances of persons interested in keeping the members in bondage. Workingmen are not free to vote as they please or to have opinions of any kind affecting the stability of associations. They are governed and held by two powerful agents, to wit: personal violence and ostracism. This last, while not dangerous to life or limb, is potent in the hands of unscrupulous men, and is all the more effective because the exhibition of it does not violate the law. No one, whether workman or business man, can long endure being sent to Coventry for no fault; and through this and the constant misrepre-

sentations of so-called yellow journals, even conservative men are dragooned into supporting measures they do not believe in. This is, briefly, the condition of things today in most parts of the United States, and that it is contrary to common sense and the Constitution of the land everyone is aware.

What is the remedy? Opinions upon this point are diverse. Some amiable, well-meaning persons seem to think that much can be done by providing workmen with more or less luxurious retiring and lunch rooms, where they can meet at noon hour and talk together, under the refining surroundings of flowers and music if they wish to avail themselves of it; but these innovations are not general throughout the country, and, more than this, they are not popular with workingmen and women at large. I have heard a good many of them express themselves forcibly upon the subject of "fancy bath rooms," as they call them, and point to them as evidence that employers could pay higher wages if they chose to by carrying to the salary lists the money they cost to introduce and maintain. They look upon superior surroundings as charities, and, in some sense, as a reflection upon their social status, and will have none of them. Assuredly these provisions, intended to alleviate the irksomeness of labor, have done nothing toward establishing better feeling between capital and labor, or toward settling the issues between them, for one of the most obstinate strikes occurred in an establishment which was a model of the kind alluded to.

Another proposition to better the condition of workingmen is the profit-sharing scheme in one form or another. The difficulty with it as a permanent institution is that workmen have exaggerated ideas about profits, thinking that they run into fabulous sums, and, under the circumstances of their environment, it is not to be wondered at that they fall into such an error. They see supplies of all sorts purchased and lavishly used. The proprietors and officials generally have expensive establishments, are clothed in purple and fine linen, reck not of tomorrow, and, whether there are plenty of contracts on hand or none at all, spare not to spend. Under such conditions, I say, it is not surprising that workmen think that their gains from their daily work are too small, become restive, and demand higher wages, shorter hours, and more privileges generally. The leaders of unions dilate constantly upon this phase of the argument, sedulously harping upon the large amount of money employers make and the small sums they pay out. Therefore, when it came to sharing profits, the men naturally felt that there was a chance of getting more than they had been receiving, but they were disappointed; for the percentage allotted at the end of the

year was pitifully small compared to their expectations, and really small in any light. A workman said to me that one experience of profit sharing was enough for him, for after working twice as hard as he ordinarily did and turning out a great deal more work, all he had to show for it at the end of one year was $75; as he got $3 per day his profit in 300 days was about 25 days, about one-sixth of what he felt it ought to have been. At the same rate, he said, he would have to work ten years to make $750; by that time he would be dead—under the high-pressure system.

Another objection to profit sharing is that workmen are not financiers, and have no way by which they can tell whether they are getting all they are entitled to or not. It may be urged that proprietors of shops and their bookkeepers would not descend to unfairness in such cases, but that is exactly what the men do not know, and it must be confessed that they are prone to be suspicious.

Let me digress a moment from the main issue of this article to comment upon a peculiarity of illiterate men as regards their wages, which is known to all who have had dealings with them, and that is their exact knowledge of the amount they should have. Not of course the gross sum to be paid them weekly, but for parts of a week, or day. I have seen coal heavers, when they have been laid off for one trip, raise the ship out of water pretty nearly with the racket they made over a difference of a few cents less than they thought they were entitled to, and in many cases they were right. They simply took what was given them, went on one side in the gangway, counted it, and if it was correct went about their business. If it was not, the purser would have a very bad quarter of an hour explaining how the mistake occurred. The men never credited explanations, but went away muttering objurgations. Mechanics are, of course, not ranked with coal heavers as to intelligence, but even they are prone to overrate the sums they think they should receive whenever extra compensation is in question.

Another scheme for benefitting workmen is to induce them to take stock in the concerns where they are employed, with the two-fold purpose of enabling them to make provision for old age, and, from the employer's point of view, of reducing the possibility of dissensions about wages, etc. By whatever name such propositions may be called, they are, when all is said and done, no more nor less than co-operative concerns, with the disabilities attached to organizations of this kind. These last are many; they take all the risks of every mercantile combination, and have some peculiar to themselves. Workmen-stockholders are hard to manage and to please; they know nothing about the routine of

business, what it costs to get it, or to maintain shops and tools in working order, and fancy that so soon as any contract is completed some one stands with money in his hand to pay for it. Being all stockholders they have a voice in the direction, and cannot understand that they are unfit, for want of training, to make any suggestion at all. Co-operative shops consist usually of a force where every man is boss; then chaos comes again. The expectation is, in such schemes, that all will prosper from the start because interests are identical, and were it not for the fact that "in Adam's fall we sinned all" there would be no dissensions; but there is no prognostic for human nature, and where a number of workmen are gathered together the tower of Babel was a quiet tea party in comparison with the confusion of counsels exhibited.

In this discussion of the issues between labor and capital I do not give my own views wholly, as to the objections made to schemes to harmonize them, but have discussed the subject with intelligent workmen and employers as well, and from what they say I have come to the conclusion that they do not want to be "personally conducted," either as to their present or future prospects. This is quite natural, for every man prefers to work out his own commercial salvation, and, in so far as any Utopian plan is concerned, I do not think reliance should be placed upon it to bring universal peace to the warring factions.

Assuredly the union leaders, so called, do not desire interference of any kind between them and their ambitions. When workmen were first organized it was for the ostensible object of increasing their wages, but having succeeded in many cases in doing this they still maintain an aggressive attitude, with the object of getting recognition for their associations from employers. That is to say, they desire to have a voice in the management of affairs in shops where they are employed, to say who shall or shall not be employed, and to control the situation generally. They wish to "reap where they have not sowed," and to say what may or may not be done. A hat manufacturer recently wanted to put in a line of cheaper goods than he had been making in order to keep the shop going in a slack time, but the workmen decided that he must not do this, and when he insisted upon his right to do what he pleased with his own, every man in the shop quit incontinently. Instances like this one could be multiplied indefinitely and are of public knowledge; they are not isolated and of occasional occurence, but are examples of the "rule or ruin" attitude workmen assume toward employers at the present time. Is there any hope of a better day so long as this spirit is rife? Again, an employer in a small way of business who paid union rates had been so harrassed by dictation and walking delegates who watched

every job he undertook, that he went to a meeting of the union men, and asked them to decide definitely what he must and must not do, so that he would have something to go by in future. They rose on him in a mass, with every foul epithet and threat of personal violence they could think of, and he was glad to escape without an assault. This state of affairs cannot be changed by mild measures, but must be dealt with as the law provides. We have just had in New York instances of the lack of principle in the trade unions which are cases in point. The treasurer of one sequestrated several thousand dollars of union money; he was put upon trial and is now serving out a term of years in State prison. Another, a walking delegate, went around mulcting employers in large sums to obtain immunity from strikes; unless contractors paid "smart money" the men were ordered off of the job, and they obeyed promptly. This man was tried and convicted of extortion, but had only served a few days of his sentence when he was released upon the pretence of some irregularity in the first trial, and is now out again.

Another proposition to settle the disputes between labor and capital was for them to meet and discuss moot points and arrive at some conclusion whereby mutual losses could be avoided in future. This was done in Chicago; both sides met and discussed. The verdict was that they should pool their issues. The capitalists were to find the money as they always had done, and the workmen were to do the work at their own prices, and, also at their own convenience. Certain capitalists and certain trades have formed a coalition which is a close corporation, and no outsiders or independent workers can contract to do anything, for they are not recognized as members of the association; unless they are, they might as well go out of business. Coal dealers agree to employ none but union men, and these last agree to work for none but the coal-dealers' union, so they have control of the situation as regards one of the staples of industry. Nothing could be simpler—the only difficulty with it being that it is in restraint of trade and therefore illegal; a trifle like this does not seem to stand in the way at present, for it is in full operation. Protests have been made, and some few persons fined for breaking the laws, but the city is so thoroughly saturated with the virus of unionism that every industry is paralyzed. A report recently published shows that unions have doubled their membership in Chicago in twelve months, and that there are now something like 240,000 men enrolled. The increase in the wages paid for labor amounts, for the same period, to $1,600,000. Is there any scheme or proposition which can be brought forward to offset this prosperity in the eyes of workingmen? I do not know of any. It is better than any stockholding or

profit-sharing arrangement that can be devised, or has been put forward at the present time. Of course, it is neither more or less than commercial privateering, and like all illegal ventures will come to an end sooner or later, but this does not benefit those whose interests are now suffering from depredations.

It should be possible for every man to work when and where he pleases, and for whom he pleases; it was once so in the United States and it will be again, so soon as the laws are universally observed. Any body of men who attempt, without authority from the whole people, to dictate to other bodies of men as to lawful comings and goings, are without the pale of the law, and can be dispersed if the majority insist upon it. Usurpers are never the majority, and until the whole people demand all their rights again the arrogance of the self-constituted guardians of labor will continue. A union man was papering my house a few weeks ago, and when six o'clock came he still had ten minutes more work to do to finish. "Pull down the shades," he said, "and I will go ahead; if the business agent comes by here and sees me at work after hours I will be fined $25." Espionage of the closest kind, fines enormous in amount, and petty tyrannies at all times are visited upon members of unions without resentment or protest upon their part, and American workmen are bound hand and foot in chains of their own forging. American employers are somewhat in fault also, for the present conditions, by weakly submitting to extortion and dictation in the hope of being able to continue their contracts. Is it not somewhat incongruous that an employer should dicker with irresponsible men for a "privilege" that is already his by law and birthright?

Suppose that the employers of the United States decide that in future they will not hire any man or men without a contract for a certain time for stated wages. If the contract is fair in its provisions and both parties live up to it, there is an end to dissensions for a given time; if one or the other party ignores the instrument, there is a legal remedy, for courts everywhere consider contracts binding. The issue then is between man and man, as it was of old time, and the union is not a party to it. It may be said that this will be inoperative, for unions will not permit their members to make such contracts; in that event the issue is squarely against the union for depriving American workmen of their right to sell their services to the highest bidder, and that is a very serious indictment. Further, if picketing, tresspasses of walking delegates upon premises, and all unlawful acts were vigorously prosecuted, there would be a great improvement upon the present conditions. These measures are so easily tried that they should be.

DIAMOND MINING IN THE KIMBERLEY FIELD·

By Chas. V. Allen.

The Kimberley diamond mines, like the gold reefs of the Rand, afford an example of mining conditions under which "consolidation" is a legitimate and logical policy. Mr. Allen's present summary of the general history and methods of the region will be followed by a paper devoted especially to the mechanical equipment and appliances. For most of the illustrations accompanying this article we are indebted to the courtesy of Mr. Gardner F. Williams, author of "Diamond Mines of South Africa," and of his publishers, The Macmillan Company.—THE EDITORS.

DURING the last 23 years, the output in rough diamonds of the South African mines has been approximately $414,000,000, the value of these diamonds when cut amounting to $828,000,000. Many thousand men are employed in the work of diamond cutting. This output is approximately 95 per cent. of the total product of all the diamond-bearing countries in the world.*

The first diamonds mined to any extent were in India, and later in Brazil, where diamonds were discovered by the Portugese in 1728.

In both countries, diamonds have been found to some considerable extent; the date of discovery in India, however, is not known. Here, as in Brazil, they were washed from the gravel, small claims being staked out to individuals, surface placer mining being the method followed. As diamond-bearing countries, Brazil and India amount to very little compared with the districts afterwards discovered near the junction of the Orange and Vaal rivers in South Africa. No diamonds of any amount have been found outside of Brazil, India, and South Africa. The diamond fields of South Africa were discovered in 1867, and it may prove interesting to know that the first diamond was discovered by a Boer, Van Niekerk by name, this diamond being found near the junction of the above mentioned rivers. It at first attracted attention as being merely a bright stone, and was sent to Dr. Atherstone, a leading mineralogist of the colony, who pronounced it a diamond. Its weight was 21.25 carats, and it was sold for $2,425 to Sir Philip Wodehouse, governor of Cape Town. Further search did not disclose other diamonds until 1869, when a few of smaller size were picked up by the natives. In 1869 a large white diamond, weighing 83.5 carats, was found on a farm near the Orange River. This was

* It is estimated by an expert of international reputation that the value of the diamonds brought into the United States is approximately 75 per cent. of the valuation of all precious stones and pearls imported. This also represents fairly the percentage in other countries.

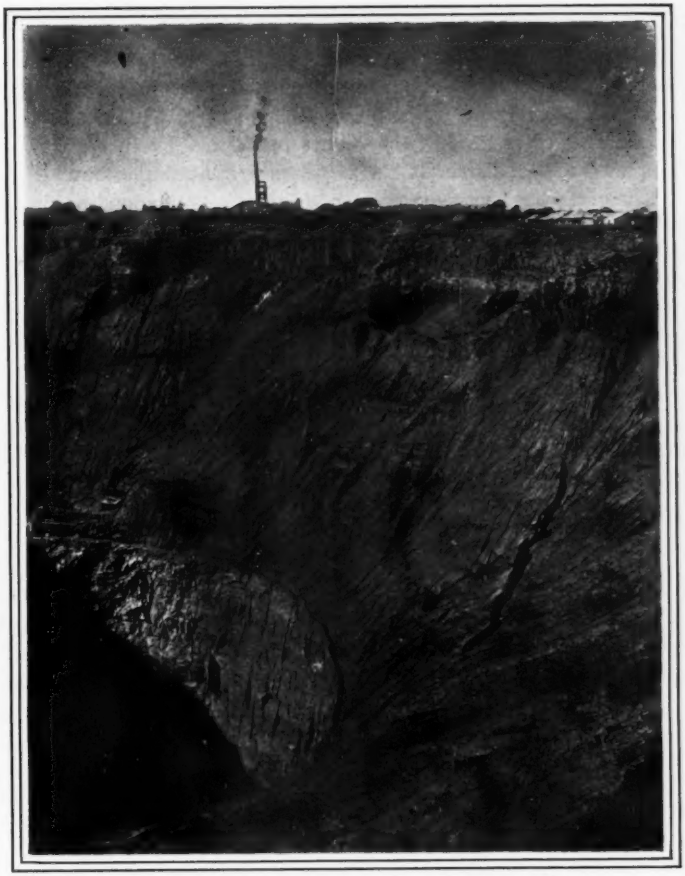
sold for a sum of 500 sheep, 10 oxen, and 1 horse, and later sold for $53,320 in Hope Town, and again sold for $121,250 to the Earl of Dudley, this diamond becoming known as the "Star of South Africa." Soon after this placer diamond mining was started on the Vaal river,

KIMBERLEY REEF SLOPES, 1874.

with the result that more diamonds were found. The news spread rapidly, attracting all nationalities, until the banks of the stream for some distance were staked off into small claims, resulting in the forming of a town of 2,000 diggers, with stores and a newspaper.

The finding of diamonds on the rivers led to further search in other districts, diamonds being found in 1870 at Jagersfontein. In 1871 diamond mining was started in Kimberley, claims being staked here as at previous places, each claim measuring 31 feet square with fourteen roadways 15 feet wide crossing the fields north and south 47 feet apart. At the river diggings it was not supposed that diamonds could be found below bed rock, or that they extended to much, if any, depth.

The surface of the country around Kimberley is covered with a red sandy soil, and it was soon ascertained that the diamond-bearing ground was located in sort of volcanic pipes or necks, which were probably at one time filled from below with a mixture of fragments of surrounding rocks mingled, forming the bluish colored, hard mass.



THE KIMBERLEY MINE AT THE PRESENT DAY.

in which the diamond was embedded. This bluish color is due to the presence of lower oxides of iron, and this "blue ground," as it is known, is soapy to the touch, about the hardness of sandstone when mined, and readily friable when exposed to the air and moisture. In this blue ground Mr. Moissan has found some eighty species of minerals. The yellow ground is found below the surface red soil at a depth of 70 or 80 feet, and it was first supposed that diamonds, which were found abundantly in the yellow ground, would not be found in the blue ground beneath it. This theory proved erroneous, as time has

shown, the yellow ground above being blue ground which has been acted upon by atmospheric influences, peroxidizing the iron and thus changing the color. The famous diamond mines in the neighborhood of Kimberley are the De Beers, Kimberley, Dutoitspan, Bultfontein, and Wesselton. Other mines in the neighborhood are now being worked for diamonds but as yet they are unimportant.

Kimberley has become the center of the present diamond-producing area, and a description of these mines, therefore, gives practically an outline of the world's diamond mines of today. Besides the mines above mentioned, there are two of some importance in the Orange Free State, known as Jagersfontein and Koffeefontein, about 60 miles from the Kimberley diamond region. The above five diamond mines are contained in a circle of three and a half miles in diameter, and comprise irregularly shaped round or oval pipes extending vertically downward to an unknown depth, keeping about the same diameter as far as they have been mined at the present time. The areas of the four principal mines are as follows:

Kimberley,	33	acres.
De Beers,	22	"
Dutoitspan,	45	"
Bultfontein,	36	"

Kimberley and De Beers mines were worked first from the surface and proved the most valuable of the four, these holes being sunk to a depth of several hundred feet. The rock outside of the mines is known as the "reef," and is not diamond-bearing. This reef caused no little trouble to the surface miners by its continually caving in and covering their individual claims. At one time, within the small area comprising the claims being worked open from the surface, there were 3,143 individual claims. Each of these was, as previously stated, 31 feet square, one digger being allowed to own and control but two claims. In the early mining the diamond-bearing ground was carried on wire ropes in rawhide buckets to the surface level. The yellow ground was at first sorted dry by screening the coarse ground out of it. Later it was washed in pans, and, when "blue ground" was struck, it was spread out exposed to the weather until it had sufficiently crumbled.

In November, 1883, 250,000 cubic yards of reef fell into the Kimberley mine, covering the tops of the claims half across the mine. In 1884 the first real underground mining was begun, a shaft being started in the reef, but abandoned as too expensive when 320 feet below the surface. In 1876 the population of Kimberley consisted of 8,000 whites and 12,000 to 16,000 blacks.

The need of proper organization in the mining industries was very much felt, owing to the fact that the mines, which were at times partially filled with water, required expensive pumping machinery to allow the mining to proceed, and again, the falling in of the reef was so troublesome as to render surface mining practically out of the question. The only alternative, therefore, was underground mining, but this was very expensive and could not be carried on by individual claim owners.

Up to 1885 there were still 98 separate holders in the four mines—in Kimberley 11 companies and 8 private owners, in De Beers 17 companies and 3 private owners, in Dutoitspan 6 companies and 21 private owners, and in Bultfontein 8 companies and 24 private owners. So that in the four mines there were 42 companies and 56 private owners, contending within an area of 70 acres comprising 3,600 claims; therefore, up to this time, after fourteen years of mining in the "each for himself" method, all claims had been thus far united.

At this time Cecil Rhodes became prominent in the diamond-mining history of South Africa. He was interested largely in the De Beers Mine, whereas Barnett Barnato, a former diamond buyer, was equally interested in the Kimberley Mine. In 1880 Rhodes formed the De Beers Mining Company with a capital of $570,000, comprising three firms. The same year, Barnato came into the control of the Kimberley Central Company. The contention between these two companies was considerable, each controlling one of the two largest diamond mines in the world. As a result of their fighting each other, the price of diamonds on the market dropped as low as $4.32 per carat. Rhodes, foreseeing the trouble and the difficulty of operating the mines successfully with this state of affairs, repeatedly tried to purchase Barnato's controlling stock in the Kimberley mine, and in 1889 succeeded, the price paid for the controlling stock in the Kimberley Central Company being $25,882,292, which payment was made by check, this check being the largest ever presented and paid in cash up to that time.

The name of the new organization was known as the "De Beers Consolidated Mines," this company later taking in a greater part of Dutoitspan and Bultfontein, which latter amounted to $70,375,000, although the capital of the De Beers Consolidated Mines remained at $19,157,500. After the combination, the net profit of the year was found to be over $4,850,000 and 20 per cent. was paid to the shareholders. This was a vast contrast to the result which had been obtained previous to the combination, when competition was in force. All the mines in the Kimberley divisions for this year produced an output of 2,415,655 carats, which was approximately 90 per cent. of the total

product of diamonds for the year. The following table shows the increased production and valuation of diamonds from 1873 to 1888, the amount during the years from 1873 to 1880 being estimated.

Year.	Carats produced.	Value per carat.	Total value.
1873-1880.....	1 to 1,500,000	——	——
1883.....	2,319,234	$4.89	$11,352,640.00
1884.....	2,264,786	5.57	12,406,181.00
1885.....	2,287,261	4.61	10,515,709.00
1886.....	3,047,640	5.16	15,740.060.00
1887.....	3,646,889	5.16	15,819,947.00
1888.....	3,565,780	5.29	18,862,976.00

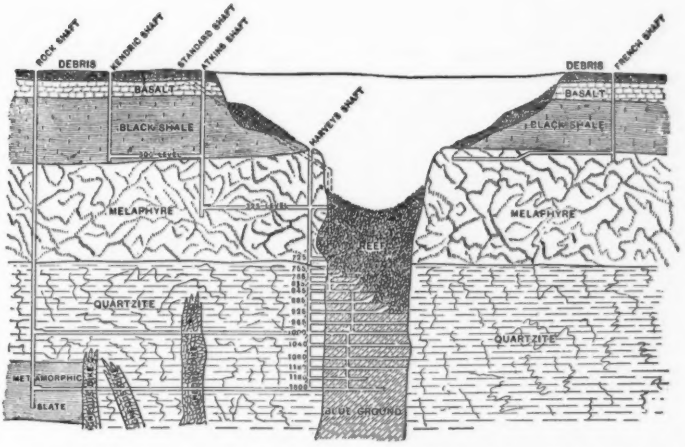
The contents of the several pipes constituting the different mines differ decidedly in character. The diamonds of each mine have a distinctive character, so much so that an experienced buyer can tell by the appearance of a stone the mine from which it is taken. Dutoitspan yields principally white stones; Bultfontein, small white stones; Wesselton, clear stones of irregular shape, mostly white. The diamonds from Jagersfontein in the Orange Free State are extremely rare in color, having a steely sort of lustre. These stones are worth nearly double those from Kimberley and De Beers.

In order to get an idea of the enormous value of the Kimberley mines, it might be well to state that two claims measuring together 62 by 31 feet and worked to a depth of 150 feet produced 28,000 carats of diamonds. The blue ground varies in the amount of diamonds it contains in the different mines, but remains fairly constant in any one mine. In 1890, the yield per load of blue ground (each load weighing 1,600 pounds) was:

Kimberley Mine	1.25 to 1.5	carats.
De Beers Mine	1.20 to 1.33	"
Dutoitspan Mine	.17 to .5	"
Bultfontein Mine	.5 to .33	"

Underground Mining.—After the consolidation of all these mining interests, Gardner F. Williams, who had been in charge of the De Beers Mine since 1887, assumed management of the entire consolidated interests. It was at this time that a great number of engineering problems had to be solved, inasmuch as surface mining must necessarily be done away with and some method of obtaining the valuable blue ground by a system of underground mining must be developed. After some years of careful study and much expensive experimenting, the method of underground mining at present in use was adopted, which is very well described by Sir William Crookes after a visit.

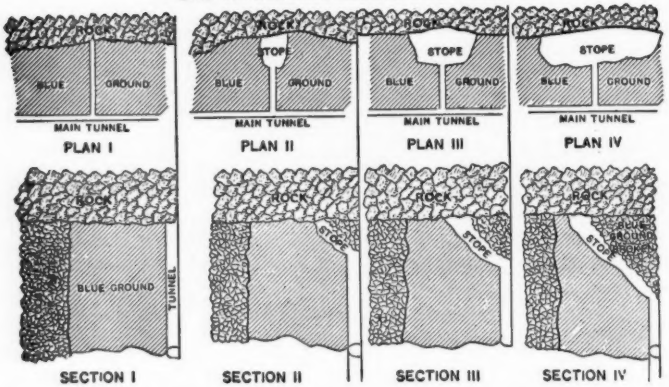
SECTION OF KIMBERLEY MINE
LOOKING EAST
100 50 0 100 200 300 400 500 FT.
SCALE



"Shafts are sunk in the solid rock at a sufficient distance from a pipe to be quite safe against reef movements in the open mine. The main shaft at De Beers starts about 540 feet from the north side of the mine, and is now over 1,500 feet deep. Tunnels are driven from the shafts at different levels to cross the mine from west to east, about 120 feet apart. These tunnels are connected with each other by two tunnels running north and south, one near the west side of the mine, and one midway between it and the east margin of the mine. From the east and west tunnels offsets are driven to the surrounding rock. When near the rock, they are widened into galleries, these in turn being stoped on the sides until they meet, and upwards until they break through the blue ground. The fallen reef, with which the upper part of the mine is filled, sinks and partially fills the open space. The workmen stand on the falling reef, and drill the blue ground overhead; as the roof is blasted back, the débris follows. When stoping between two tunnels, the blue is stoped up to the débris about midway between the two tunnels. The upper levels are worked back in advance of the lower levels, and the works assume the shape of irregular terraces. The main levels are 320 feet apart, with intermediate levels every 40 feet. Hoisting is done from only one main level at a time. By this ingenious method of mining, every portion of blue ground is excavated and raised to the surface, the rubbish on the top gradually sinking down and taking its place."

The interior of the diamond mines resembles not a little the appearance of a coal mine in its method of working. In the De Beers mine

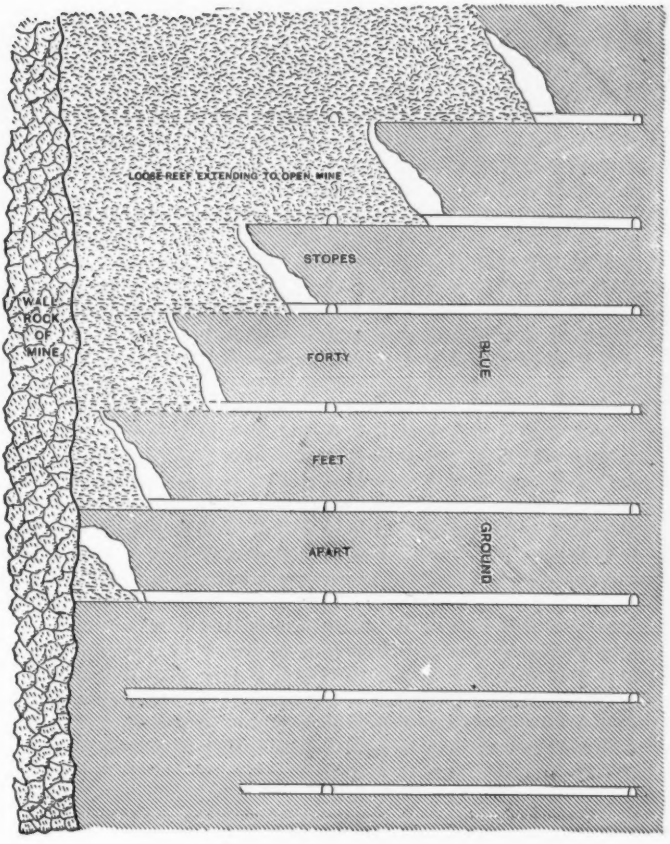
SKETCH SHOWING METHOD OF STOPING



there are now eleven levels on which work is being done, these levels beginning at the 800-foot level and running down to a 1200-foot level. In the Kimberley mine nine levels are being worked between the 1200-foot level and the 1500-foot level. The galleries from which the blue ground is taken are not supported by props, however; the tunnels in the blue ground are supported at intervals by two heavy props, having a cap of round timber over them, this being covered by 1½-inch lagging.

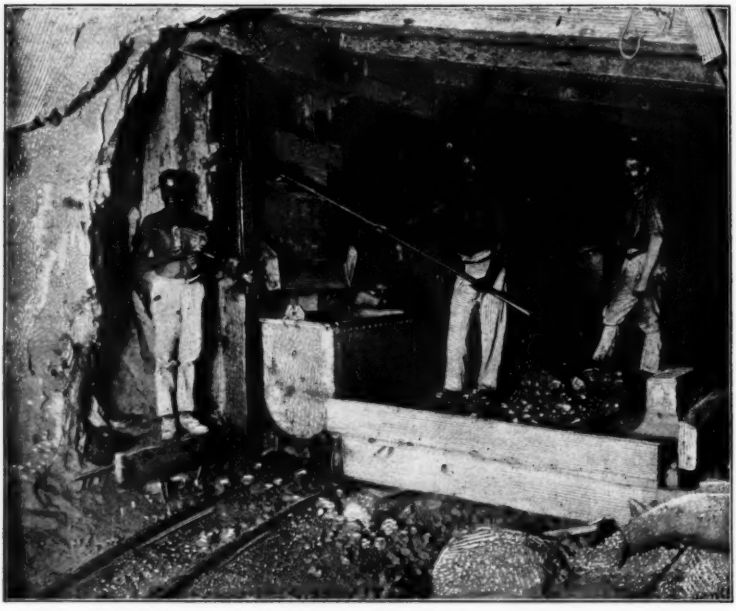
Parts of this ground are quite soft, whereas other parts are more of the hardness of sandstone, as previously stated. The soft blue ground can be drilled with what is called "long jumper drills," which are sharpened at both ends, whereas the hard blue is drilled in the usual way, using single hand hammers. In this work, natives are employed almost entirely, and after a time become very skilled in their work, performing quite as much as would white men under similar conditions. The mined blue ground is shovelled into trucks holding 16 cubic feet and hauled along tunnels by endless chains. The motive power until recently has been compressed-air engines, the air being piped in from the surface. These are being supplanted by motors. The trucks of blue ground are run into a large station about 30 by 70 feet cut out of the solid rock back toward the mine from the shaft, the tunnels themselves being 8 by 11 feet. This blue ground is emptied from the trucks into chutes, and from them turned into the skips and hoisted to the surface, each skip holding six trucks full, or 96 cubic feet, the weight of each truck load of blue being 1,600 pounds.

The tipping of trucks into the loading chutes at the bottom of the



VERTICAL SECTION, SHOWING METHOD OF STOPING.

various shafts has hitherto been done by means of the ordinary revolving tippler, and the expense for labor in connection with this has been high. This is now accomplished by using 20-cubic-feet side-tipping trucks instead of the old 16-cubic-feet end tippers, the trucks leaving the electric haulage line and running by gravity round the shaft, being tipped and righted automatically, and coming back again for attachment to the haulage without requiring any labor except that necessary for reattachment to the haulage rope. This has resulted in reducing the working cost and makes the handling of larger quantities of ground



LOADING THE TRUCKS.

possible. For hoisting from the 1,520-foot level, 40 seconds is required. After the blue reaches the surface, it is tipped from the skip into surface chutes where it is drawn into side-tipping trucks holding 20 cubic feet, the weight of each being 2,000 pounds. These cars are hauled by an endless wire-rope haulage to the depositing floors where the blue is spread out to a depth of one foot for exposure to weather, in order that it may crumble and thus be easily worked in the washing machines.

These trucks in passing from the mouth of the mine shaft to the depositing floors are greased automatically while in transit, and every fourth in passing to these floors registers automatically as five loads of 16 cubic feet, making 80 cubic feet in all in the four trucks. Each truck load is spread out to cover about twenty-one square feet. The exposure to the sun and rain causes the blue ground to crumble, and it is harrowed occasionally by steam traction engines drawing wheeled harrows with huge teeth back and forth over the floors, turning and returning the lumps. The hardness of the blue ground varies in the different mines. In the Kimberley, it becomes well pulverized after three months' exposure, whereas the De Beers product requires ap-

proximately six months. The longer the exposure, however, to which the ground is subjected, the more pulverized it becomes and consequently the better for washing.

These floors extend over many square miles of country and are surrounded by a 7-foot barb-wire fence, this being guarded by day and night. Powerful 2,500-candle-power search lights are thrown across these floors all night to prevent theft. On account of the long exposure necessary, especially in the case of the De Beers blue ground (which contains a much larger quantity of hard blue than do the others), the harder lumps are of late being passed through crushing mills, in order to hasten the process, and consequently not to tie up so much capital for so long. It is estimated that about 14 per cent. of all the ground sent to the depositing floors is too hard to weather.

Before referring to the method of extracting the diamonds from the blue ground, we will return to the mines. Here among some of the engineering problems which have to be met with is the matter of drainage. At first, steam pumps were used to pump the water from the mines, this steam being piped down the shafts, as a result of which the moisture and heat cause the blue ground near at hand to crumble, the ladder ways in the shafts at times proving impassable on account of the excessive heat. The water pumped from the mines is used at the surface to aid in the pulverizing of the blue ground deposited upon the floors, as in some seasons there is very little rainfall, so that the action of the elements upon the blue ground is extremely slow if it be left to nature. The supply of water about Kimberley would be insufficient for this purpose were it not for that obtained from the mines. The amount of water pumped at the De Beers mines in 1889 was approximately 6,000 gallons per hour, and the pumping was accomplished by a compound surface-condensing 120-horse-power engine, made by James Simpson & Company of London, the high-pressure cylinder being 14¾ inches diameter, low pressure 21 inches, stroke 30 inches. At the Kimberley mine in 1891 there was installed a Cornish pumping engine of 400 horse-power, this being a triple-expansion condensing engine with cylinders 15½ inches, 23¼ inches and 27 inches diameter, 36 inches stroke. This engine pumped on an average 12,000 gallons a day. Compressed air has heretofore been used in the mines, replacing steam for driving sinking engines, mechanical haulages, rock drills, and the like. At this writing, a still further development is found in the adoption of electricity.

A problem which has still further troubled the engineers of this vast mining industry is the prevention of what is known as "mud

rushes." Water accumulates in the open mine above and finds its way below through the debris, finally breaking through into the tunfound in the adoption of electricity for supplying a greatly needed want, nels with a rush, filling them in a few minutes with a quantity of mud and oftentimes causing loss of life on account of the impossibility of the workmen in the tunnels making their escape. In order to obviate this, various methods were tried, until now the mines are well drained by special passes in the rock. Tunnels have been made around the open mine, in order to catch the water and prevent it from entering the mine.

Another problem which has been more easily solved has been that of lighting the various shafts, tunnels, and galleries. Electricity has now been adopted entirely for lighting purposes throughout the various underground tunnels, as also for the various ladder ways. In the stopes, however, and other places which are being worked, candles are still used. The lighting of the tunnels by electricity has proved especially valuable in aiding the men to escape from the mud rushes.

For some time electric bells and telephones have been generally installed throughout the entire mine, the bells being used in connection with the hoisting, thus saving a great deal of time over the old method; the telephone system is now very extensive throughout the entire plant, connecting depositing floors, concentrating works, offices, and the various underground levels.

The veltilation of the mines is another problem which must be met, and in the case of the De Beers and Kimberley mines this is provided for to a great extent by natural air currents. In the case of the De Beers mine, the air passing in and out amounts to 145,000 cubic feet per minute, and in the Kimberley mines, 25,500 cubic feet per minute.

In these mines there were employed in 1897 above ground 1,126 whites and 3,528 blacks; underground, 500 whites and 3,812 blacks, thus making a total of 8,966 in all. The number employed have increased to quite an extent since then, until from 10,000 to 12,000 are at present at work in and about the mines. These men receive compensation for their work as follows:

Mechanics	$24.25	to	$33.95	per week.
Miners	24.25	to	29.10	"
Guards and tally men	19.40	to	24.25	"
Engine drivers	29.10	to	33.95	"
Natives working blue ground	.72	to	1.20	per day.
Overseers	17.45	to	19.88	per week.
Machine men and assorters	24.25	to	29.10	"
Ordinary native laborers	4.00	to	3.04	"
Drivers	6.00	to	6.60	"

In addition to the above, a premium is paid each employee in proportion to the value of the diamonds found by him, either on the depositing floors or within the mines. On the floors the white men receive 36 cents and the natives 6 cents per carat. About double these amounts are paid for stones found in the mines.

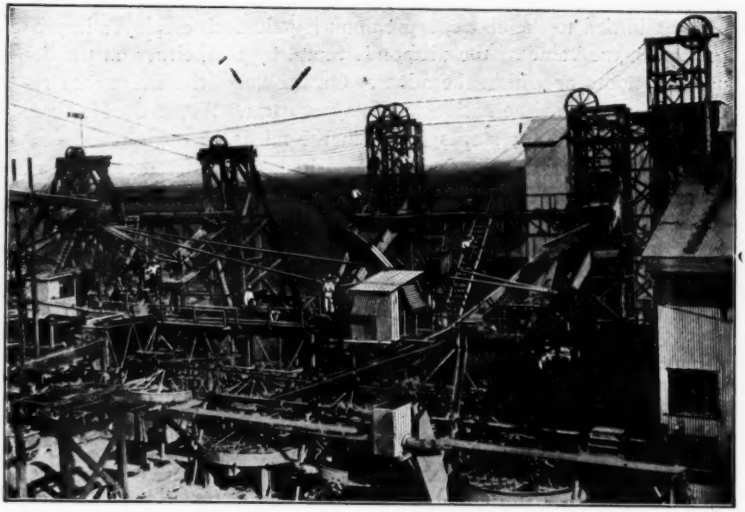
The blue ground is now mined, deposited, and watered at a cost of 52 cents per load, the average yield of diamonds for the last several years under the present management having been 3/10 of a carat per load from Premier mine, and about 8/10 of a carat from De Beers and Kimberley mines.

It was found that the Dutoitspan mine could not be worked further from the surface to advantage so that at the end of 1889 work was suspended, the market at that time being well enough supplied with diamonds. In 1901 a shaft was started at this mine for future underground working.

The Bultfontein mine proved more profitable than the Dutoitspan; however, in 1889 a large reef fall covered nearly the entire open mine so that work was shortly afterwards suspended until 1900. During the past few years this mine has been opened up for underground mining and is now ready to be worked on a large scale. The shaft is down to the 600 feet level, above which there are 13,000,000 loads, equal to 10,400,000 tons of the blue ground in sight.

The methods pursued in extracting the diamonds from the valuable blue ground necessitate considerable handling before the diamond is ready for the market. However, the ancient laborious methods of sorting such diamonds and washing by hand have been greatly improved, until we now find labor-saving machines doing almost all the work. The methods of extracting diamonds we may refer to herein briefly.

The ground is taken from the depositing floors and hauled in 20 cubic foot trucks by wire rope to the washing machines, where it is dumped automatically into hoppers, the bottoms of which are small revolving tables. Here the ground is divided and automatically conveyed by motor-driven belt conveyors into revolving cylinders. This automatic feeder not only divides the ground equally between the rotating washing machines, but delivers it regularly so that the machines cannot become overcharged, the result of which would be the loss of many diamonds. There is one of these cylinders for each section of the machine, each cylinder being capable of sizing 2,000 to 3,000 loads per day. After leaving the automatic feeders the ground is mixed with "puddle," a thick muddy water, which flows out of the



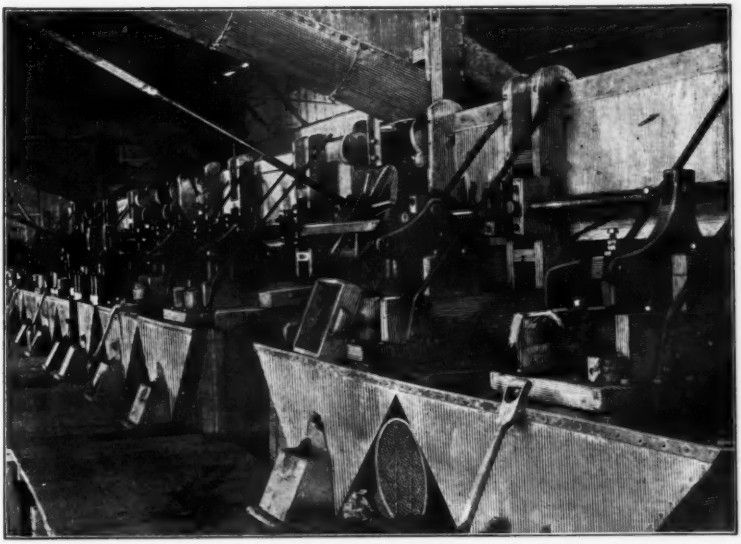
NO. 2 WASHING PLANT, DE BEERS FLOORS.

washing pans, clear water being added constantly. This mixture then flows into a revolving cylinder covered with perforated steel plates having holes 1¼ inches in diameter, all lumps larger than the holes passing out of the end of the cylinder and being carried by a motor-driven pan conveyor to crushing rolls for further treatment.

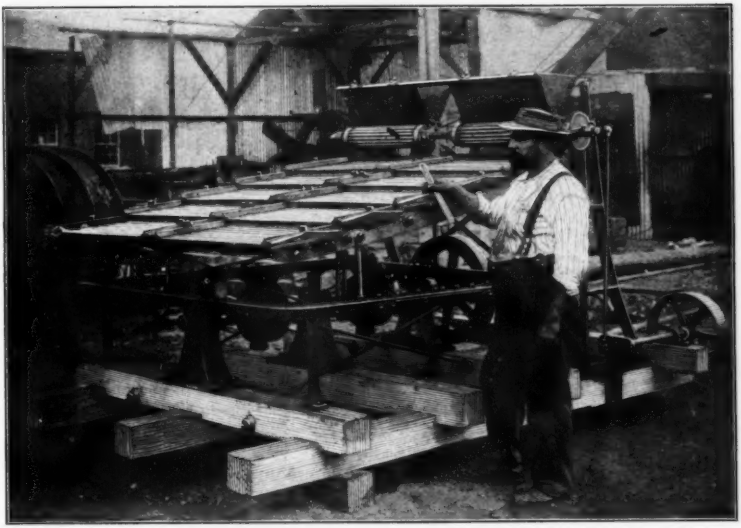
That which goes though the holes of the screen passes into shallow circular pans, where the ground is carried around by revolving arms with teeth so that the diamonds and heavier matter pass to the outside and the lighter matter flows out at the discharge in the inner rim; thence it goes through a screen, and is finally carried away by an endless chain of buckets to the waste heaps.

All the pans are fitted with patent extractors, by means of which the diamonds deposited are removed every two hours. The entire gear is driven by means of three 220-volt electric motors. Suitable motors have been installed at various points, and the drives so arranged that one motor drives two pans. The coarse rolls and the fine rolls are also arranged to be driven by separate motors. The various conveyors, screening cylinders, etc., are motor-driven.

As a result of this treatment there is obtained what is called concentrated deposits or "concentrate." This concentrate is then sent in covered locked trucks to what are known as the "pulsators," where it is



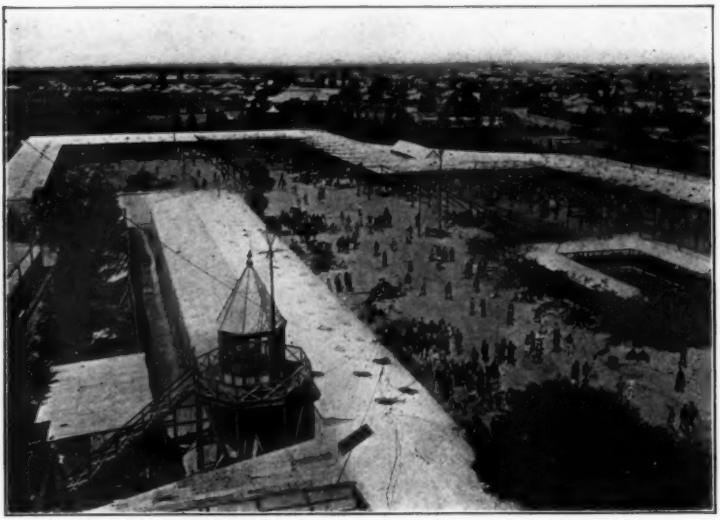
THE PULSATOR.



AUTOMATIC DIAMOND SORTER, CALLED THE GREASER.

divided into various sizes by passing through a cylinder covered with steel sieving with holes 1/16 to 5/8 inch diameter. Through these five sizes of holes the stones fall and pass from the pulsators by means of conveyors to small hoppers located above mechanical sorters called "greasers," or grease tables.

For a long time it was considered possible to extract the diamonds from the concentrate left after passing through the pulsators only by careful and repeated hand sorting, the concentrate passing first through the hands of white sorters and later native employees. This tedious process was studied carefully by many, and finally Mr. Kirsten invented



THE DE BEERS COMPOUND, OR LIVING QUARTERS OF BLACK LABORERS.

a machine known as the "greaser." He noticed that diamonds and other precious stones adhered to grease, wheres other substances seemed to pass over it. As a consequence, therefore, after much experimenting, he developed the mechanical sorter which consists of a sort of table built up of various steps, these steps being one above the other and each on quite a little incline. These step surfaces are covered with grease and vibrated rapidly. The concentrate is allowed to drop on the table gradually from the hopper above, and in passing over the various steps of the table the diamonds adhere to the grease. The first table recovers all but 1/3 of 1 per cent. of the diamonds, the con-

centrate afterwards being passed over a second table where practically all of the diamonds are collected. The grease on these tables is renewed every few hours, the old being scraped off and steamed in kettles to separate, the grease passing away to tanks of water where it is cooled and again ready for use. The diamonds are then boiled in caustic soda to get rid of the grease.

Before the invention of these grease sorting machines, out of 12,000 loads or 192,000 cubic feet of blue ground washed daily at the De Beers and Kimberley mines 160 cubic feet had to be sorted by hand. With the above mechanical sorter now but about 1 cubic foot reaches the hand-sorting table, the saving being due to the efficiency of these mechanical sorters, which fact well illustrates the vast importance and value of such invention.

In making mention of these labor-saving inventions it might be added that a machine for loading the blue ground from the floors direct into the trucks which haul it to the washing machines is now being experimented upon.

The diamonds, which have now been separated, are taken under armed escort to the valuators in the general offices, where they are cleansed by boiling in a mixture of nitric and hydrochloric acids or in fluoric acid; after this they are sorted carefully as to size, color, purity, and made into parcels for sale.

To provide for the ten or twelve thousand men employed in or about these mines the management have had many problems to meet which were all aside from the mining problems themselves. There are now in use at these mines twelve compounds, the largest being at the De Beers mine. This one covers four acres and provides shelter for 3,000 people. Provisions and essentials can be bought at the compound store, there being an understanding with the local dealers in the town and the government so that they only sell the necessaries of life, the price being the same as at outside stores. In addition to this the compound is provided with a hospital, dispensary, church, and school. A large concrete swimming pool occupies the centre of the enclosure. The native's cabins or rooms are situated on the outside of the grounds forming a square or rectangular area in the centre. These cabins are lighted by electricity. All applicants for positions must sign contracts binding themselves to live in these compounds at least three months, and longer if they desire, not being allowed to leave until their contract expires.

Every possible protection is taken to prevent loss of diamonds by theft, the men being examined twice daily to make sure none are con-

cealed about the person. These examinations take place upon entering and leaving the mine.

The underground work in the mine is conducted day and night in three shifts. Contractors employ natives to mine and truck the diamond ground at a fixed sum per load; however, a worker must drill a certain number of holes for blasting or load a fixed number of trucks before he has earned his compensation. These natives usually work in gangs of ten or twelve, those of the various tribes being kept together at their work as well as in the compounds. All natives are placed under responsible white overseers.

As giving an idea of the enormous growth of this industry since its consolidation, the following table, which is taken from the De Beers Company's report of 1902, may prove interesting. The increased price of the diamonds since competition was renewed at the time of consolidation is plainly seen.

	De Beers and Kimberley Mines.			
	Year ending March 31, 1889.	Year ending June 30, 1894.	Year ending June 30, 1896.	Year ending June 30, 1898.
No. of loads of blue hoisted...	944,706	2,999,431	2,698,109	3,332,688
No. of carats of diamonds found	914,121	2,308,463	2,363,437	2,603,250
Value of diamonds produced...	$4,373,817	$13,677,825	$15,352,103	$16,738,391
No. of carats per load.....	1.283	.89	.91	.80
Value per carat	$4.73	$5.86	$6.42	$6.36
Value per load	$6.07	$5.25	$5.84	$5.06
Cost of production per load...	$2.37	$1.56	$1.68	$1.58

	Premier Mine.			Bultfontein Mine.
	Year ending June 30, 1902.	Year ending June 30, 1898.	Year ending June 30, 1902.	Year ending June 30, 1902.
No. of loads of blue hoisted...	2,062,459	1,146,984	1,932,140	353,042
No. of carats of diamonds found	1,499,299	189,356	521,437	4,486
Value of diamonds produced...	$4,373,817	$13,677,825	$15,352,103	$16,738,391
No. of carats per load	.76	.27	.30	.21
Value per carat	$11.15	$4.98	$8.04	$7.27
Value per load	$8.52	$1.36	$2.39	$1.62
Cost of production per load...	$2.02	$ .62	$ .82	$1.56

EDITORIAL COMMENT

OUT of the fog which veils the march of events—or the progress of palaver—in Bogotá, as we go to press, come many and diverse rumors. The semi-mediæval remoteness and isolation of the Colombian capital are conditions highly favorable to the breeding of *canards;* the long silences of the interrupted communication are the chosen times for the stalking abroad of the "high authority" and the flight of the "special dispatch." Mr. Leigh's leading article in this number gives a most interesting and useful picture of the condition of the mainland of the Republic—territorially far superior to the isthmus, politically the most difficult and yet the controlling element, but almost unknown, probably, to many who have an excellent knowledge of the single small State of Panama. The knowledge of the country and the people thus given is materially helpful in reaching an understanding of the Colombian congress in which, as we write, the treaty is still being debated.

Criticism of this legislative assembly, as Mr. Leigh well remarks, is largely forestalled by the embarrassing recollections of the weeks of futile debate in our own Congress. We were not always nationally wise in seeing the truth, even when it stared us in the face. Memories of Senator Morgan must temper our impulse to lose patience with the senators at Bogotá. Neither dignity nor common sense would be served if at the first petulent outfling of a petty State we should abandon our tacit undertaking to give the world the best waterway, and turn in meek discouragement to an inferior course. But of this line of action there is now, we believe, fortunately very little fear.

* * *

THE difference between professional and political investigation of an engineering matter is most strikingly shown by a comparison of two reports upon transportation in New York City—the one issued by the State railroad commissioners in June, the other by the engineering and sanitation committee of the Merchants' Association in September. The gentlemen from Albany put forth the results of their labors in a little pamphlet of 24 pages, 14 of them filled with tables valuable only as the bases for analyses or comparisons which the State officials do not make. The text is very largely an expression of vaguely amiable and hopeful opinions that everything is going to be very nice. "There has been an improvement on all of the lines." "We believe a marked change for the better will be shown." The companies have promised many things—for example, the widening and other improvement of a number of downtown stairways "as soon as practical," the changing of many crosstown lines to underground electricity, the immediate increase of power for the Brooklyn lines—and the commissioners, in happy contentment, say: "There—that's fixed!" But they can be stern when requisite. They have ordered "that the elevated cars be painted as early as practicable," that "clearly legible signs reading 'Smoking on five rear seats only' be placed in each car

in which smoking is allowed," and that "the grab handle on the bell shaft be remodeled so as to be about seven inches nearer the conductor."

And yet the congestion of traffic is not relieved!

It is a deep satisfaction to turn from this Gilbert and Sullivan production to the thorough and earnest study by the engineers of the Merchants' Committee on Engineering and Sanitation. It makes a book of 216 pages, of which about 90 are tables and diagrams directly pertinent to the text. The systematic arrangement of the study is admirable, the results well digested, well presented, and well supported by evidence, and the remedies proposed in almost every case are temperate, practicable, and such as commend themselves to common sense and justice.

* * *

THERE has been much wise talk emitted concerning the importance of technical education to the engineer, while at the same time it is often painfully evident that certain portions of some more elementary branches might also be included. It has been said that an engineer's first duty is to do things, but he is often called upon to say things as well as to write about the things he has done or is doing. For this purpose a full command of at least one language is essential, and yet attention has frequently been drawn to the fact that many otherwise able engineers are deficient in the ability to use their native language in such a manner as to express themselves clearly and correctly.

There are, of course, brilliant examples of engineers whose expression is as clear and direct as their thought—whose words are as well chosen as the materials of construction they build into their work—whose writings are models of strong, simple language, well used; but in many instances the papers which are submitted to technical societies and technical periodicals would create much surprise if published exactly as written, and the combination of eminent names and curious English might in some cases produce an impression almost painful.

It is by no means desirable that an engineer should also be trained to write a highly polished literary style, and any tendency toward "fine writing" would be most ludicrous, but he should at least be able to write a report, or prepare a paper for a professional society, without making blunders for which a schoolboy would be punished or a stenographer reprimanded.

That such a deficiency lies in the training must be apparent. A man must be able to think clearly before he can become a good engineer, and the training in pure and applied mathematics through which he must pass cannot fail to impress upon him the necessity for accuracy in the statement of facts when he uses formulas, tables, or diagrams. With the instincts of an engineer, with the knowledge of the necessity for absolute accuracy in the selection of data and the deduction of results, a man must have the capacity for becoming a master of clear and intelligible English, if only he is given proper opportunity. The diplomat may well say that "language was given to enable us to conceal our thoughts," but engineering and diplomacy have different ends in view and may well use the same tools to attain different ends.

The present agitation for higher as well as more practical technical training will certainly be incomplete if it fails to include fuller and better methods for instruction in the right use of the English language as an effective and essential instrument for the use of the engineer in his work of directing the great sources of power in nature for the use and convenience of man.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

MODERN TRANSATLANTIC STEAMSHIPS

THE SUCCESS OF THE HIGH-SPEED GERMAN VESSELS AS COMPARED WITH BRITISH AND AMERICAN LINES.

Engineering.

IN a recent editorial in *Engineering* the question of Britain's supremacy on the Atlantic is discussed and a comparison is made betwen the popularity and success of the more modern German vessels and the best ships of the British and American lines. This discussion is apropos of the formal completion and signing of the agreement between the government and the Cunard Steamship Company and the efforts to be made by the British line to regain the position which has been lost.

Since the completion of the Campania and Lucania, more than ten years ago, no serious attempt has been made by British naval designers to exceed the speed of those vessels, about 22 knots, and England has apparently remained content to allow her mails to be carried across the Atlantic more slowly in vessels sailing under her own flag than can be done by the foreigner; ignoring in the councils of her government, the inquiries which have been made as to the reasons why both Englishmen and Americans have to mark their letters especially for the German vessels which may choose to call at her ports, rather than to entrust them to the Post Office to see that the best possible service shall be had.

The travelling public, quite willing, to choose the best, under whatever flag it may be found, has not been slow to express its appreciation of the superior service afforded by the German vessels, and, as *Engineering* remarks, it is only necessary to examine the returns of the passengers embarking on various ships to reveal the preference shown, not only for the high-speed vessels, but for the vessels which give the most satisfactory service in all respects. Without going into the details of the lists it will suffice to say that during the later weeks of April and the earlier part of May of the present year, when the east-bound traffic was beginning to assume its best proportions, the swift German vessels took out from three to five times as many first-class passengers as did the best British and American boats. In one week one of the best German boats carried as many first-class passengers as did the four other vessels of the same week, these latter boats being American, British and French. The same results are shown by an examination of the west-bound lists in the later season, when the same passengers were returning to the United States, thus showing that the experience on the one voyage led to its repetition on the return.

As to the cause of this preference for the German boats, there are several points to be considered. The writer of the editorial in *Engineering* dwells upon the preference of the travelling public for high speed, and in many instances this is doubtless the controlling influence. Apart from the advantages gained by controlling the maximum speed for the purposes of carrying the mails, the government is interested in the provision for vessels of maximum speed which may serve as cruisers in event of war, and it is this latter contingency which has doubtless led to the stringent provisions of the agreement with regard to the speed of the proposed ships for the Cunard line. The

agreement between the government and the Cunard Steamship Company is of sufficient interest to be examined here. The amount to build the two steamships, necessarily large, but dimensions not stated, is £2,600,000, this to be furnished by the government, and secured on debentures at 2¾ per cent. interest, while an additional annual payment of £150,000 is to be made upon the condition that the ships shall be capable of making a minimum average speed of 24½ knots in moderate weather. If this speed is not maintained, a deduction is to be made from the annual payment by agreement, provided the speed does not fall below 23½ knots. What is to happen if the speed falls below 23½ knots does not seem to be altogether clear, but apparently the ships may either be rejected, or their fate is to be determined by arbitration.

Apparently the real incentive which has led to the advancement of government aid to a private company is the fact that the organization of the International Mercantile Marine Company practically took the control of the fast White Star steamships, upon which the government had relied in time of war, out of British hands. Into the exact facts of this feature of the case it is not now necessary to go, as it is sufficient to know that what the effective competition of the German lines could not accomplish has been effected by the realization of the fact that naval strength might be impaired.

According to *Engineering*, the designs for the new ships are in an advanced stage, and although it is not yet announced by whom they will be built, it is understood that one of them will be built on the Clyde and one on the Northeast Coast. They are to be built to plans and specifications approved by the Admiralty, and, in conformity with naval practice it is the intention to make the machinery in both cases in duplicate, or in other words, to adopt as far as possible the principles of standardization. An inspector or is to be appointed mutually by the Admiralty and by the Cunard company to carry out the work according to the plans and specifications approved, so that the ships will represent the best that British mechanical constructors can give, and will also be the most satisfactory compromise between the requirements of passenger and mail service and of cruiser duty in time of war.

Apart from the incentive of high speed and quick crossings, however, there are other things which affect the partiality of the travelling public for the German transatlantic steamers. First and foremost, a ship is intended to cope with the perils of the sea to the very best possible degree, and in this respect British-built vessels and British seamen stand in the first rank. Skill and safety being granted, the ocean liner is next considered as a hotel, and as first-class hotels the German vessels are so infinitely superior to the English boats that the traveller is quick to recognize the difference. On an English vessel the passenger is made to feel that he is altogether subordinate to the details of administration, while on the German vessels the entire relation of the service to the passengers is reversed, and there is the same systematic, effective, and courteous personal service which is found in a first-class Continental hotel. There is little doubt that it is this question of superior service, and careful attention to the personal comfort of the passengers which is turning the bulk of ocean travel to the vessels of the Continental lines, and this element can be met without the expense and delay of building larger and swifter ships.

THE THEORY OF NICKEL-STEEL ALLOYS.

DEDUCTIONS FROM THE EXPERIMENTAL INVESTIGATIONS CONDUCTED AT THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

C. E. Guillaume—Revue Générale des Sciences.

FOR some time the peculiar properties of certain alloys of nickel and steel have attracted much attention, their behavior, both as regards magnetic and thermal, differing widely from that of either of the constituents. Although these properties have been carefully studied and given certain practical applications, notably through the efforts of M. Guillaume, no definite theory to explain them has yet been

framed. In an article in this magazine for October, 1901, M. Guillaume discussed some of the more important of the nickel-steel alloys, and now, in two important papers in the *Revue Générale des Sciences*, he further examines the experimental results which he has obtained in the course of his work at the International Bureau of Weights and Measures at Breteuil, near Paris, and shows how a theory may be outlined to accord with the observed facts.

Briefly, the alloys of nickel and steel, or of nickel and iron, may be divided into two groups, named by M. Guillaume as the reversible and the irreversible alloys. These two classes may best be described by referring to their relation to a peculiar property of a special alloy. Both iron and nickel, as is well known, are magnetic metals, that is, they are attracted by a magnet. Of the various alloys of the two metals, however, the one containing 25 per cent. of nickel, is non-magnetic, thus differing in this respect from both of its constituents. When this alloy is cooled it becomes magnetic, but when the original temperature is restored the magnetism disappears. Alloys containing less than 25 per cent. of nickel are magnetic, to a greater or less degree, and although this property disappears on heating, it returns upon cooling. When the nickel content exceed 25 per cent., the alloy becomes magnetic on cooling, but when heated the magnetism disappears and does not return upon subsequent cooling. There are a number of minor peculiarities about these various alloys, but in general they may be divided into reversible and irreversible alloys, that is, those in which the magnetic properties come and go upon cooling and heating, and those in which the property does not return when the metal is cooled. These distinctions are not strictly complete, but will serve to indicate the classification according to magnetic properties.

The thermal properties are also both curious and contradictory. Both iron and nickel follow the ordinary laws of expansion and contraction, increasing in volume when heated and diminishing when cooled, each having its own coefficient of expansion, and being fairly uniform in this respect. The alloys, however, show a curious variation from these usual conditions. The alloys containing a small percentage of nickel have practically the same coefficient of expansion as iron, but above 25 per cent. of nickel the coefficient rapidly diminishes, until, when the proportion of 36 per cent. of nickel to 64 per cent. of iron is reached, the coefficient of expansion has fallen to such a low value as to be almost inappreciable, being only about one-tenth of that of platinum. This alloy has been given the name of *invar*, presumably because of its invariability under temperature changes, and it has already found important practical applications in the form of measuring tapes and wires for geodetic work, and for the suspension rods for pendulums for clocks, as well as for minor standards of length. For alloys of a higher nickel content than 36 per cent., the expansion coefficient again rises, until it approaches that of nickel, or nearly that of iron. In the course of this range of variation, it is possible to find a combination which has practically the same coefficient as glass, this furnishing a material capable of replacing the more costly platinum for fusing in glass connections where other metals are inapplicable.

In addition to the peculiarities in respect of magnetic and thermal properties, exhibited by the various nickel-steel alloys, similar effects are found when the elasticity is examined. The irreversible alloys show, for a lowered temperature, an irreversible diminution in the modulus of elasticity, contrary to the normal phenomena, while the reversible alloys show a reversible diminution in the modulus.

The explanation of these various peculiarities is not easy, and no fully acceptable theory has yet been found. M. Guillaume, however, seeks to discover it in the behavior of the two states of the iron in the combinations. It has been demonstrated by various investigators that iron undergoes certain physical changes during heating and cooling; and the phenomena of recalescence, and of the changes from the *beta* to the *gamma* states, are well known. The coefficient of expansion of iron is expressed by a formula containing two terms, and the second of these indicates an important action under the influence of heat. Thus the coefficient of expansion remains practically uniform until a temperature of about 900° C.

has been reached, when for a short period a contraction occurs, after which the expansion proceeds again uniformly. Nickel, on the contrary, shows no such action, the expansion coefficient continuing practically uniform. Now, according to the theory of M. Guillaume, the influence of nickel, when alloyed with iron, is to cause these peculiarities of the iron to become apparent at much lower temperatures than is the case with the pure metal. In other words, according to M. Guillaume, the addition of nickel transports the changes in the state of iron under heat into the region of ordinary temperatures, thus enabling the phenomena to be observed with ease, and permitting them to be utilized.

The details of the theory, together with numerous diagrams and data concerning the behavior of the two metals and their alloys, are given at length in the papers to which reference has already been made, and the whole series of researches on which they are based forms an admirable example of painstaking study and investigation. Apart from their importance in the industrial arts they form a contribution to the science of metallurgical physics which must be considered as one of the most striking of recent times.

POSSIBLE ECONOMIES IN ELECTRIC LIGHTING.

PRESENT AND PROBABLE IMPROVEMENTS IN LAMPS, EQUIPMENT, MANIPULATION AND METHODS.

W. A. Chamen.—Municipal Electrical Association.

THE competition which is constantly going on between the various methods of artificial illumination is fruitful in the production of improvements and atempts at improvements which represent, on the whole, a continual advance both in the character of the light produced and in the cost of its production. Both of the elements form the subject of a paper presented before the Incorporated Municipal Electrical Association by Mr. W. A. Chamen, from which we make some abstracts indicating the general trend of present effort.

Taking up first the ordinary incandescent lamp, Mr. Chamen asks:

"Is there any probability that the carbon filament is capable of being worked, with satisfaction as to its lasting properties, at any materially higher efficiency than the 3½ to 4½ watts per candle-power to which we are accustomed? The outlook in this direction does not seem very encouraging, though some 8 c. p. 250-volt lamps recently tested in Glasgow have started with an efficiency of 3½ watts per candle, while, after 600 hours of burning, the efficiency has not gone below 4½ watts per candle, thus showing that this degree of efficiency is not confined to lamps of 16 c. p. or over. Some 12 months or more ago an incandescent lamp bearing the name of "Crawford-Voelker" was brought out, having a filament alleged to be made of some carbide and promising considerable improvement in efficiency as well as long life. As, however, nothing has been heard of this lamp for some time, it must be assumed that some difficulties have arisen in its manufacture which have so far prevented its coming into market."

Leaving the filament lamp out of further discussion, the Nernst lamp, with its glower exposed to the air, is next considered, and in view of the extensive experience which has already been had with it during the past year it must be considered as fairly beyond the experimental stage.

"The results of recent experience from several different sources show that an everage life of 600 hours is by no means too much to expect, and doubtless this figure will be improved upon as time goes on. As regards economy, the claim put forward is that, light for light, the Nernst lamp consumes about half the energy consumed by the ordinary carbon filament incandescent lamp. Assuming the useful life of the latter to be about 800 hours, and that, roughly, eight lamps of 16 c. p. will give as much light as one 1-ampere 250-volt Nernst lamp, it will be seen that at an efficiency of 4 watts per candle some 409 units will be consumed by eight ordinary 16 c. p. lamps in 800 hours, the cost of which, at, say, 4d. per unit, equals about £6. 16s., to which must be added the cost of renewals—viz., eight lamps at, say, 1s. each=8s. or a total of £7. 4s. With

the Nernst lamp the cost of energy will be about £3. 8s., to which must be added the cost of renewals or, say, one and one-third times 3s. 6d. (if we include the resistance as well), say, 4s. 8d., a total of £3. 12s. 8d., being a saving of £3. 11s. 4d., or nearly 50 per cent. This is a good margin to allow for even more frequent renewals of Nernst filaments, &c., and the average Glasgow consumer has not been slow to grasp the point, particularly in business premises where the charge for energy is 6d. per unit for the first 365 hours' use of maximum demand, and 1d. per unit for all further quantity. The fact that the filament requires heating before it will conduct the current, an operation requiring about half a minute, is against the Nernst lamp to some extent, but in many cases it is of no real consequence."

As a suggestion in connection with the improvement of lamps of this kind, Mr. Chamen remarks that as substances are known which will give off a brilliant light when heated to a moderate extent, there appears to be no apparent reason why some combination of carbon filament with some one of these materials might not be made which would unite the advantage of instantaneous lighting with that of high efficiency. Various attempts are now being made to produce lamps of this sort, but nothing practical has as yet been evolved.

Another line along which material progress has been made is seen in lamps using incandescent vapour as the illuminating medium. Of these the principal is the Cooper-Hewitt mercury-vapour lamp, concerning which much has been written, although but a limited number of the lamps has been made.

"It consists of a glass tube about 1in. in diameter and some 3ft, or 4ft. long, having a bulb at the bottom containing mercury and an iron electrode at the top. The tube is hermetically sealed and the air is exhausted to a considerable degree. The electric current is passed through the tube from the electrode at the top, which is connected to the positive pole of the circuit, to the mercury in the bottom. The working pressure for a tube some 3ft. or 4ft. in length is about 100 volts, but a much higher pressure is required to start it. This is produced by the insertion of a simple self-induction coil connected in the lamp circuit and coupled up with a switch in such a way that the tube can be momentarily short-circuited, thus putting the coil direct on to 100 volts pressure. On breaking this switch the kick or extra E.M.F. produced by the coil forces a passage through the tube, starting the mercury into vapour, and immediately a steady current commences to flow. The light at first is tinged with purple, but as the tube warms up it becomes whiter. The peculiarity of the light itself is that there are no red rays in it, and its effect upon the beauty of a rosy complexion is disastrous. This cannot, of course, be set right by making the tube of red glass. A plate of red glass, which will let through floods of red light from a ray of sunshine, acts almost like a total eclipse when applied to the Hewitt lamp."

Various improvements have been made in the arc lamp since its first practical introduction for general lighting. Among these may be mentioned the enclosed arc, enabling lamps of lower candlepower and longer life to be made than was possible with the older form with exposed carbons. This has come into extensive use and must be considered as a real improvement. Another method of increasing the efficiency of the arc is the mixing of various substances with the carbon, usually barium, calcium, or strontium compounds, these enabling a much longer arc to be maintained, and filling the space between the carbons with incandescent material. This method has enabled the efficiency of the arc to be nearly doubled.

"There are, however, still some objections and difficulties to be overcome before this type of lamp can come into general use for street lighting. Firstly, the consumption of carbon is very much greater than with the ordinary type of arc lamp, thus necessitating trimming at more frequent intervals. Secondly, the light is not so steady as that of the ordinary arc, having a continual quiver rather like a badly-burning gas flame. Thirdly, it does not seem to have been possible so far to produce a satisfactory burning lamp which will give the same candlepower as the present 10-ampere lamp with a consumption of only half the energy. All that has been brought about seems to be the doubling of the light without altering the present consumption of energy, and this is hardly what is required in ordinary street

lighting. The light given by an ordinary open arc of 10 amperes (which one may take as being in round figures 1,000 c. p.) is a sufficiently large unit for almost any class of street lighting, and in many cases a 7½-ampere lamp is ample for the purpose. One cannot but feel, however, that all these difficulties will, in one way or another, disappear as time goes on and as various further improvements are developed.

Apart from improvements in the lamps themselves there are possible gains to be made in handling and manipulation. Thus the duration of burning, when properly used may enable a considerable economy to be effected in trimming and attendance. The use of double-carbon lamps of 38 to 40 hours running makes it possible to trim the lamps every alternate day, thus doubling the number of lamps which can be put under the charge of one trimmer and his helper, while with the 60-hour enclosed arc lamps the two men can care for three times as many lamps with the same amount of labor, an important economy being thus effected.

In general, therefore the possible economies in electrical illumination do not yet appear to be exhausted, and it is possible that by increased efficiency and decreased attendance costs there may be very material reduction effected, especially in connection with street lighting.

PETROLEUM MOTORS FOR MARINE USE.

APPLICATIONS OF INTERNAL-COMBUSTION MOTORS ON VESSELS FOR AUXILIARY PURPOSES AND FOR PROPULSION.

A. Bochet—Société des Ingénieurs Civils de France.

IN comparison with the remarkable increase in the use of internal-combustion motors for driving automobile vehicles on land their applicability for marine service has, to a large extent, been overlooked. A number of small launches have been equipped with naphtha or gasoline motors, but these have usually been small boats intended for intermittent service and regarded rather as toys than as permanent installations of motive power.

In a paper recently presented before the *Société des Ingénieurs Civils de France,* and published in the *Mémoires* of the Society, M. A. Bochet discussed the more important applications of internal-combustion motors to marine purposes, and the examples given by him show very effectively the extent to which such motors have been seriously considered for such service.

M. Bochet considers only such motors as operate with heavy petroleum, the machines using gasoline or essence being considered unsuitable, both because of the operative cost and by reason of the danger from fire. Of these motors, by far the greater number in use on shipboard are employed for auxiliary purposes, and for sailing vessels, in which there would otherwise be no available source of power, they have been found of great value. Thus, petroleum motors have been applied for the driving of dynamos for electric lighting, enabling sailing vessels to be provided with electric search lights as well as incandescent lights for general interior illumination, and experience has shown that motors for this purpose are as reliable and steady under the varying conditions of weather and motion as are steam-driven generating sets.

For modern large sailing vessels, in which the great economy of transport is assured, and in which it is desired to operate with as small a crew as can be practically employed, the use of auxiliary machinery for handling the sails has become well established. In most instances a small steam plant is installed and a number of winding engines and other auxiliary machinery disposed independently about the vessel. The low economy of such an arrangement is apparent, and the intermittent character of the service, together with the necessity for prompt and effective operation in cases of emergency renders the internal-combustion motor especially well adapted to the work. Each petroleum motor may be placed in the most desirable location, independently of the others, and the absence of any boiler or pipe connections simplifies the arrangement very materially.

The use of petroleum motors for propelling purposes is limited by the size of the machines at present constructed, these rarely

exceeding 200 or 300 horse-power, but as auxiliaries to sail power they may be most effectively applied. M. Bochet cites a number of instances on the Swiss lakes, notably on the Lake of Constance, in which auxiliary motors have been installed with much success. At first the sailors were timid about placing any great dependence in the motors, believeing that they would prove unreliable, but with increasing experience the popularity of the machines has rapidly extended, and at the present time nearly all the commercial sail boats on the lake are equipped with motors, ranging from 6 to 18-horse-power, and rendering them independent of calms or adverse weather. At the present time there are 42 sail boats on the Lake of Constance which are provided with auxiliary petroleum motors, and the volume of merchandise transported has quadrupled since their introduction, owing to the greater reliability of the service. Boats of 80 to 90 tons displacement are propelled at a speed of about 12 kilometres an hour by motors of 18-horse-power.

Another service in which auxiliary motors have been applied with success is found among the fishing boats off the French coast. The addition of a small motor and propeller to the sail power renders such boats independent of adverse weather conditions and permits them to reach and return from the fishing grounds with the least loss of time. As the motor can readily be started when wanted it is used only when the wind fails, but in such cases the possession of even a small amount of motive power becomes of the greatest service. M. Bochet illustrates the equipment of a 53-ton fishing boat in which a 20-horse-power motor, fitted with a compressed air starting device supplies ample power, the manœuvering being effected by the use of a propeller with reversible blades.

It is very desirable that motors for use on boats or vessels should produce as little vibration as possible, and many of the single cylinder machines operating upon the Otto cycle are unsuited for the purpose. By using several cylinders the turning moment may be made nearly uniform and the reciprocating parts so disposed as to balance each other, but this leads to more complication than is desirable for small motors, and M. Buchet shows a design of a motor made by MM. Sautter-Harlé & Cie., in which the explosion occurs between two pistons moving in opposite directions, giving a complete balance with a simple arrangement of parts. By combining such a motor with a spring suspension all vibration is prevented from being transmited to the vessel, and the presence of the motor is not appreciably felt.

The most interesting application of an internal-combustion motor to marine propulsion which has yet been made is that of the Diesel motor, of which a special machine of 20-horse-power has been designed and installed upon a boat in active service upon the Rhine-Marne canal. The high economy and effective performance of this motor in stationary service should render it equally effective for use upon vessels, and it is altogether possible that it may become extensively applied as a source of marine motive power.

EXPERIMENTS ON AIR RESISTANCE.

RESULTS OF INVESTIGATIONS UPON THE RESISTANCE OF THE AIR TO THE MOVEMENT OF FALLING BODIES AT THE EIFFEL TOWER.

M. G. Eiffel—Comptes Rendus.

NUMEROUS experiments have been made to determine the resistance which the air opposes to a moving surface, but the results have been rather discordant. In view of the meagreness of reliable working data available, the paper presented to the French Academy by M. G. Eiffel, the well-known engineer, and published in a recent issue of *Comptes Rendus,* is of value and interest. This communication contains a resumé of the results of experiments conducted by MM. Cailletet and Colardeau upon the resistance opposed by the air to the movement of bodies allowed to drop from the second platform of the Eiffel tower at Paris, and the care with which these trials were conducted, as well as the extensive scale of the experiments adds to their technical importance.

The important question, from an engin-

eering point of view, is the determination of the manner in which the pressure of the wind acts upon stationary bodies, and the action upon concave, convex, and inclined surfaces is at the present time far from being definitely understood. It is, however, accepted that the resistance of the air to a moving body is not greatly different from the pressure of wind moving at the same velocity, and under similar conditions against a fixed body, and hence experiments like those undertaken at the Eiffel tower possess a direct practical value.

It has been fairly well demonstrated that for velocities below 50 metres per second, or about 10,000 feet per minute, the pressure is proportional to the square of the velocity. If it is assumed that the pressure is directly proportional to the surface upon which it acts, we have as a simple expression of the pressure of the wind upon any surface:

$$P = K\ S\ V^2,$$

in which S, is the area of the surface; V, the velocity of the wind, and K, a constant to be determined by experiment. In general practice this constant K is taken as equal to 0.125 kilogrammes, so that a wind of 1 metre per second would exert a pressure of one-eighth of a kilogramme upon a surface of one square metre area.

When it is attempted to apply this rule to various cases, however, it is found that the results are often far too high, so that either errors have been made in determining the velocities, or else the coefficient K, has been taken too large. Professor Langley, in the course of his investigations, has reduced the value of K to 0.08, or about two-thirds of the above. Nearly all such experiments, however, have included the use of the Robinson anemometer for the measurement of the wind velocity, and the difficulties involved in the calibration of instruments of this type make it desirable that some more precise method be used.

The apparatus employed in the experiments at the Eiffel tower consisted of a flat plate, weighted to about 120 kilogrammes, and falling freely with as little resistance as possible. It was guided by a vertical cable and carried the recording apparatus with it, this apparatus consisting of a pulley, rolling upon the guide cable, and operating the recording drum; a tuning fork, indicating by its vibrations the time intervals; and a spring dynamometer connection between the surface plate and the carriage, to enable the pressure at every point of the course to be recorded. Since the actual velocity was recorded at all times, the retarding effects of frictional resistances were eliminated.

Experiments were made from two heights, one of 90 metres and the other of 45 metres, while three sets of plates of various forms were used, these having relative areas of 1, 2, and 4; and all of them exposing a surface at right angles to the direction of motion.

The general results are tabulated in the paper of M. Eiffel, to which reference must be made, but the important points are here briefly given. In the first place, it is shown that the coefficient K is not a constant, but varies with the surface, being greater for larger plates than for smaller ones. The variation appears to depend, not directly upon the areas of the surfaces, but upon their perimeters, a relation already indicated by the experiments of Hagen and others. Within the limits of the experiments made at the Eiffel tower, the value of the coefficient K is closely given by the relation:

$$K = 0.032 + 0.022\ p,$$

in which p is the perimeter of the surface under consideration. The mean value of K, for a circular plate of 0.30 metre in diameter, moving at a velocity of 40 metres per second, is 0.054, which is much lower than any of the values hitherto employed in practice. For a square plate of one-tenth of a square metre in surface, the coefficient by the formula is 0.06, or only about one-half the value in common use. The value of this coefficient, as given by D'Aubuisson, is 0.113; the formula of Hagen gives 0.085, which is the same as is given by Dines; Professor Langley uses 0.08; while the experimental results of Cailletet and Colardeau give 0.07.

So far, the experiments have been made only upon flat surfaces, moving in a direction normal to the pressure, but it is proposed to continue the trials with surfaces of various shapes and in different positions, and there is little doubt that valuable additions will be made to the store of data relating to this important subject.

It has long been realized that the present methods of computing the resistance of structures exposed to wind action are unsatisfactory, and some eminent engineers have asserted that much unnecessary expense has been incurred in providing for stresses which never occur in fact. Much of the uncertainty which attends the question is due to the generalization from experiments made upon a small scale or under special conditions, and it is only by the use of apparatus and methods reproducing within reasonable limits the actual conditions that reliable working data can be expected. The experiments of MM. Cailletet and Colardeau are a step in the right direction, and should give useful information concerning the direct pressure of the wind acting with a uniform velocity, and when extended to surfaces other than plane and normal to the direction of pressure they will be of great value. At the same time the most serious effects of the wind upon resisting structures are caused by the action of sudden gusts and violent puffs, the true force of which it is most difficult to determine, and which it is almost impossible to reproduce in an experimental manner. In this respect the action of the wind is similar to other shocks and impact effects which can only be covered by a margin of safety which has been found sufficient in established practice.

It is possible that the force of such gusts might be determined, after a time, by the erection of structures of a determinate surface and resistance, these being placed in exposed situations and allowed to remain until destroyed by the wind. By making a series of such structures of various resistances the margins of safety existing between those wrecked and those remaining might at least establish limits between which the mean of safety and economy would be found. The elements of uncertainty in all such determinations forbid too close dependence upon results claiming a high degree of precision, but it is at least some evidence of progress to see such determinations as those described by M. Eiffel.

MINERAL RESOURCES OF THE UNITED STATES.

A REVIEW OF THE NATIONAL MINERAL WEALTH AND THE CONDITIONS OF ITS COMMERCIAL DEVELOPMENT.

Charles Kirchhoff—National Geographic Society.

IN the course of an address delivered before the National Geographic Society, Mr. Charles Kirchhoff reviewed the mineral resources of the United States in a manner which gave a very complete idea of the extent of the national wealth in this department, and some abstract of his paper is here given. Even with the large study which has been given to this important subject it is not yet possible to speak with precision of any country, since new discoveries are being made from time to time in all lands, while in the United States especially the extent of the country and the difficulties of exploration of many portions render it impossible to do more than discuss present operations and indicate the future lines of development.

Mr. Kirchhoff takes the one case of coal, however, and makes a rough estimate of the resources of the United States in comparison with other countries, and his figures are interesting. Of an estimated coal area of about 4,650,000 square miles in the world, China is credited with 4,000,000 square miles! The United States has about 280,000 square miles; Great Britain, 11,900 miles; Germany, 1,770 miles; France, 2,086 miles, and Belgium, 510 square miles. It is not safe however, to compare the values of these figures directly, since area is not a true measure of value. The anthracite fields of Pennsylvania include an area of only 468 square miles, but these are undoubtedly of more value than any coal area of like extent anywhere in the world. Passing from coal to other mineral products, Mr. Kirchhoff gives a resumé of the geographical location of the important minerals and a brief historical review of their development, showing that it was not until the latter half of the nineteenth century that enterprise was seriously turned to the mining industry, and that its greatest achievements in the United States have been crowded into the past thirty years.

Reviewing the growth during the past twenty years, it is shown that the value of the mineral product of the United States had risen to about $370,000,000 in 1880, reached $620,000,000 in 1890, and, according to the statistics collected by Dr. David T. Day, of the United States Geological Survey, exceeded $1,000,000,000 in 1901.

"This includes $350,000,000 for coal, $242,000,000 for pig iron, $87,000,000 for copper, $78,000,000 for gold, $66,000,000 for petroleum, $55,000,000 for stone, $33,000,000, commercial value, for silver, $27,000,000 for natural gas, and $23,000,000 for lead.

"We stand first as producers of coal, our output in 1901 having been 263,000,000 long tons, Great Britain following with 220,000,000 tons, and Germany with 153,000,000 tons, our percentage of the world's total being about 31 per cent. In petroleum we have been racing with Russia, occasionally first and sometimes second. In 1901 we furnished a little over 69,000,000 barrels to the world's total of 165,000,000 barrels, our percentage being 41.9 per cent. as compared with Russia's 41.5 per cent.

"In the manufacture of pig iron we have now reached the point that our production is greater than that of our largest rivals, Great Britain and Germany, put together, with Belgium thrown in. We manufactured in 1902 fully 40 per cent. of the world's total.

"The gold production of the world was about $265,000,000 in 1901, to which we contributed $80,000,000 and Australasia $77,000,000. Of course, when the Rand resumes its full production and again starts on its natural increase, we shall probably have to yield first place to it.

"The world's production of silver has a commercial value of about $103,000,000. Here again we occupy the first rank, with Mexico as a close second.

"The supremacy in the copper mining industry is undoubtedly ours for many years to come. In 1901 we produced over 52 per cent. of the total of the world's yield of 512,000 tons. In that year, with a product of 269,000 tons, we came close to the entire world's output in 1890, when it was 273,000 tons."

In the midst of such a mass of mineral wealth it is doubtless true that abuses have accompanied their development, and that in many instances the principle that it pays to waste has been deliberately followed.

"Within certain limits that may be economically justifiable. In a new country, without adequate transportation facilities, high labor, and difficult surroundings, it is possible only to select the best and the richest, but unfortunately in mining that process of selection in most cases practically renders unavailable for the future that which has been rejected. Much of it is forever lost to the world, and what can be saved at a later date can be recovered only at a greatly increased cost. In the early days of our mining we have been unskillful, and even to-day we are robbing nature's storehouses of treasure, often destroying more than we utilize. At one time, not so many years since, barely one-third of the anthracite coal in our beds finally reached the consumer. The other two-thirds were lost in mining and in preparation for market."

An important feature in connection with the development of the mineral resources of the United States is the question of their control by powerful monopolistic combinations of capital. Although this contingency might seem remote in view of the magnitude of the mineral resources, yet a closer examination of the conditions gives it a somewhat different aspect.

"The conditions affecting the industrial utilization of mineral property vary greatly, and a closer study reveals the fact that a relatively small number of the deposits, through favoring circumstances, give their possessors special advantages. The deposits may be exceptionally rich or extensive, particularly pure, or may be so located with reference to the markets that they are capable of yielding an adequate supply at a cost far below others. These advantages may represent enormous sums, and can therefore be capitalized correspondingly. Unless those who control them extort undue returns, measured by earning capacity, the owners of the other less favorably located deposits cannot compete and live. Of course, the risk is always run by those who secure control of the best of the mines that new deposits as valuable may be discovered elsewhere, just as those who utilize monopolies based upon patents take the

chance that inventive genius, stimulated by opportunity, made exceptionally artificial, find means to dispute exclusive possession. There may be iron ore deposits as rich and as great as any on the Lake Superior ranges in the Rock Mountain region, yet for a generation to come they might as well be non-existent, so far as the controlling position of the United States Steel Corporation is concerned. An enormous power for good or for evil may be wielded by groups of capitalists who control the commercially available mineral resources, though they constitute only a small fraction of the total assets of mineral wealth of the country. The fact that in most cases the earning capacity of these consolidations has been rated exceedingly high furnishes a premium on the development of hitherto neglected deposits, and thus constitutes the greatest source of danger to the stability of many of these giant undertakings. What is perhaps to be most deplored is that these organizations, on their present basis, impose upon the industries dependent upon them a burden of fixed charges which must handicap this country in its struggle for an increasing share in the world's markets."

ECONOMY OF FUEL IN POWER STATIONS.

ADVANTAGES AND LOSSES IN THE USE OF CONDENSATION IN CONNECTION WITH STEAM MACHINERY.

Henry MacLaren.—Institution of Mechanical Engineers.

AMONG the papers presented at the recent meeting of the Institution of Mechanical Engineers one which attracted much discussion was an examination of the economy of fuel in electric generating stations, with especial reference to the question of the value of the condenser as a means of saving fuel. The author of the paper, Mr. Henry MacLaren, stated in the beginning that he had taken his data from the tables of costs published weekly in the *Electrical Times*, these again being based upon the returns made by the various public and municipal lighting authorities to the Board of Trade. Referring especially to the returns for the year ending with the close of March, 1902, Mr. MacLaren recalls the fact that this was a period of exceptionally dear coal, and goes on to state the following points, in connection with his argument:

"The first point that attracts attention is the great difference in cost per unit generated in these stations. They are located in various parts of the country; some are condensing, others partly condensing or non-condensing stations, the price paid for coal varies largely, and different systems of supply are used. All these considerations affect the costs.

"In the returns for the lighting stations, the figures are based on units sold to consumers, and therefore include the large leakage or loss in the mains, which is debited to the generating plant. This may be as much as 20 per cent., and is a very important factor to be kept in mind when comparing purely lighting stations with tramway or railway plants, that "meter" the current as it leaves the station.

"Engineers would naturally expect that condensing stations would show a better fuel economy than non-condensing, both for tram and lighting purposes, but so far as lighting only is concerned it is just the reverse; the average, both in fuel and works costs, is considerably in favor of non-condensing stations. Where trams are added to lighting, the condensing plants show a better economy than non-condensing, but in all cases the partly condensing station is the most economical, both in fuel and works cost.

"Works costs include fuel, oil, water, waste, stores, wages of workmen, repairs, and maintenance. It is manifestly unfair to compare purely lighting stations, which have only a poor load factor, with stations that combine lighting and tramways, and generate large quantities of current all day long, and meter it as it leaves the station."

Subdividing the various stations under consideration into groups which may be considered fairly comparable, Mr. MacLaren finds that for 22 stations supplying light only, the cost in pence, per kilowatt-hour, (Board of Trade Unit) was, for non-condensing plants, 1,007, while for partly condensing stations it was 0.972, and for con-

densing stations 1.169 pence. The proportion of works-costs was about the same, being 1.632 pence for the non-condensing stations, 1.576 for the partly condensing plants, and 1.999 pence for the full condensing stations. Comparisons of provincial lighting stations give similar figures, the condensing stations in both cases giving the higher costs, both for fuel and for works costs. In the case of provincial stations supplying current both for lighting and for tramways the advantage appears on the side of the condensing stations, although the partly condensing plants show a better efficiency than either of the others.

Since it is well understood that the condensation of the exhaust steam in itself should lead to a higher economy that when high pressure engines are used it is evident that the poor showing of the condensing plants must be due to causes, which, while connected in some way with the use of condensation, should not necessarily occur. Mr. MacLaren attributes the results largely to the use of separate central condensing plants, and shows the manner in which their use may lead to very wasteful operation.

"Separate condensing plants are used in most lighting stations. The vacuum in the main engine low-pressure cylinder is usually poor, owing to the long lengths of exhaust pipe, often overcharged, and having numerous sharp bends; 11 in. vacuum in the cylinder has been recorded with 23 in. in the condenser. Station engineers, as a rule, do not pay sufficient attention to this. The engines of separate condensing plants, and other auxiliary machinery, are often fitted with piston valves. Such engines may be fairly economical when new, but soon develop a great appetite for steam. They are usually fixed in inaccessible places out of sight and out of mind. Their inflated exhaust passes direct to the condenser unobserved. It is quite common to find this type using 10 per cent. of the steam required by the main engines, when working at their full load, this percentage increasing rapidly as the load falls off. A recent test of a separate condensing plant revealed the fact that it used 4 lb. of steam per unit generated by the main engines.

"Engines fitted with their own condensers have a great advantage over those exhausting into one main serving several engines, usually a saving of 5 to 10 per cent., due to the better vacuum, is effected. Add to this the 10 per cent. of steam used by the separate plant, the loss in the auxiliary steam main with its traps, the loss in starting up separate plants for short runs, the loss at light loads, the loss of vacuum through leaky atmospheric exhaust valves, and it is not so surprising that under these conditions the economy due to condensing reaches the vanishing point, or even falls 13 per cent. behind well-equipped non-condensing stations, as shown by the tables. The author's firm usually guarantee 7½ per cent. less steam per kilowatt-hour if the engines are to be fitted with their own condensers and drive their own pumps. The total cost of these engines is less than those fitted with separate condensers, and the steam required by the auxiliary machinery is altogether saved."

So far as the non-condensing stations are concerned, it appears that they beat the condensing stations by 13 per cent. in fuel economy, but this may fairly be attributed to the poor performance of the condensing plants rather than to any very high efficiency in the non-condensing engines. By using good exhaust feed-water heaters the performance of non-condensing plants may be very materially improved, especially if these are employed in connection with economizers placed in the chimney flue.

"The steam losses in electric generating engines are mostly due to valve or piston leakage—mainly the former. This applies more especially to condensing stations using engines fitted with piston valves; unless these are very carefully looked after, heavy leakage is likely to occur, the steam passing direct to the condenser. In non-condensing engines the exhaust pipe usually gives warning of leaky valves. Many station engineers do not appear to realize how serious this loss may be, and allow their piston-valves to run in a very leaky condition. Others give this matter most careful attention, and are well rewarded for their trouble. In fact, some of the most economical non-condensing stations are fitted throughout with piston-valve engines, carefully looked after and kept steam-tight. Balanced slide-valves, and valves of the Corliss type, having some pressure on the back to keep them up to the

port faces, require much less attention, and will run for many years practically steam-tight. Two recent tests of condensing engines—in different stations—fitted with piston valves, disclosed the fact that they required over 45 lb. and 50 lb. of steam per kilowatt-hour respectively. When previously tested the consumption was about 30 lb. per kilowatt in each case. Outwardly they appear to be running as well as ever. Coal to the value of £839,613 was used in the 177 stations given in the tables, during the year under review. It is safe to assume that £100,000 was lost in engine leakages alone. There is no doubt it would pay to employ an engineer in each of the larger stations to do nothing else but make tests and report on fuel losses, with a view to their remedy."

Examining the question of boiler performance, as bearing upon the general efficiency of a plant, Mr. MacLaren properly lays much stress upon the quality of steam furnished to the engines. Many of the popular water-tube boilers furnish very wet steam, not to be compared with the drier steam supplied by the older types of boilers having ample steam and water space, and operated at slower rates of combustion and evaporation. The fluctuating demands for steam also serve to render mechanical firing uncertain and often unsatisfactory, and in some cases the excessive volume of cold air which can enter gives a low flue temperature and renders this element worthless as a measure of boiler performance.

The economy in works-costs shown by the non-condensing plants may be partly explained by the fact that there is less capital invested in the simpler system, and the repairs are fewer. At the same time it is admitted that with well-designed condensing engines fitted with their own condensers the best results should be secured, and that much of the gain due to condensing is frittered away by the use of unsuitable plant and by careless management.

Taking all the points made by Mr. MacLaren into account, his paper appears to be not so much an arraignment of the condensing system as it is of the defective management which has appeared in its installation and use. There is no good reason why the system of a central condenser should not make for higher economy over that of a number of separate condensers and air pumps attached to each engine. When one-half of the vacuum in the condenser is lost between it and the cylinder, somebody and not something should be held responsible for the loss. Leaky pipe connections, together with inadequate proportions, mean poor design and general neglect, while the engineer who waits for his exhaust pipe to tell him that his engine valves are leaking should be relieved of the responsibility.

Doubtless it is true that a well-equipped condensing plant requires more and better attention than the simpler non-condensing station, but better things naturally require a higher class of attendance and should receive it as a matter of course. Mr. MacLaren's paper is a distinct indictment of the manner in which many important power stations are operated and neglected, and it is to those facts, rather than to the difference in type, that administrative attention should be directed.

STREMMATOGRAPH TESTS OF RAILS IN SERVICE.

DATA AND RESULTS OF TESTS MADE WITH THE STREMMATOGRAPH UPON PERMANENT WAY UNDER MOVING LOCOMOTIVES.

Dr. P. H. Dudley—American Society for Testing Materials.

MUCH of our present knowledge of the condition and durability of the permanent way of railways has been acquired by a study of the behaviour of the roadbed in actual service. In this study the methods included in the so-called dynamagraph car, used by Dr. Dudley, has been of great service, while the use of other methods has materially aided in this important branch of engineering research. In a recent paper before the American Society for Testing Materials, Dr. Dudley has given the results of investigations of the behavior of rails under the stresses produced by moving loads, these results having been obtained by the use of the stremmatograph, a device which records autographically upon a phosphor-bronze slide the distribution of

the unit fibre strains in the base of the rail under the wheel base of the locomotive.

Experience has shown that the best results are obtained in a railroad structure when a flexible and elastic construction is obtained. "Thus the rails and cross-ties are depressed by the wheel loads in the ballast from ⅛ to ¼-in., under the present heavy locomotives and cars. The compression of the ballast and sub-grade forms one-third to one-fifth of the total amount of the temporary subsidence of the rail. The sub-grade is affected to a depth of 12 to 20 ft., according to its material, construction and stability. There is a characteristic "general depression " of the rails, cross-ties, ballast, and sub-grade produced by each type of locomotive or car, to carry and distribute the loads, with specific deflections in the rails under the wheel contacts.

"In our present tracks the rail section acts as a continuous girder, and resolves the forces due to the moving wheel loads into horizontal components of strain in the base and head of the rails, which is partly continued through the splice bars from one rail to the next, to carry and distribute the wheel loads. The web of the rail also carries shearing strains at the points of flexure. In the section of the rail the neutral surface is neither elongated nor shortened by the deflections in the resolution of the components of strain. In the head of the rail immediately under the wheel contact the metal is in compressive strain above the neutral surface, while below the metal is in tensile strain. A strain of one character above or below the neutral surface is balanced by an opposite one in the section. The examination of a Stremmatograph record of the unit fibre strains in the rails, shows that they are a series of alternating strains of tension and compression, as the wheel loads and their spacing move over that particular p rtion of the rail."

In Dr. Dudley's paper the results of tests with the Stremmatograph are tabulated in such a manner as to show their distribution as regards the various portions of the wheel base of a New York Central locomotive, and while the figures are only approximate, they furnish some very instructive information concerning the distribution of stresses.

"When it is running, owing to the undulations in the track, also to movements of the wheels in their pedestals, and the irregular application of steam to the driving wheels, it is impossible to expect results corresponding to its supposed static wheel loading. As stated, we have a flexible or elastic track, with looseness of the rails upon the cross-ties. This must first be reduced by the weight under the forward truck wheels, which at once modifies the effect of the calculated static wheel loads of the locomotive. If the tracks were inflexible, except for the strains in the rails to support the loads, then we should obtain unit fibre stresses corresponding to the supposed static wheel loading of the engine, except for the driving wheels.

"It will be instructive to observe that the unit fibre stresses per pound of load in the rails under the forward trucks, carrying about one-half of the weight per exle of the driving wheels, are within one-fifth as much as those under the drivers, even with their added effect of the expended tractive effort. In other words, by a subdivision of the total load of the engine, a part may be used to stiffen and strengthen, not only the superstructure, but the sub-grade, to carry and distribute the heavier driving wheel loads with less deformation than would be possible without the forward truck. In the ten and twelve-wheel types of engines, for slow speeds, even more favorable results are secured. In some tests under twelve-wheel engines, at 15 miles per hour, under the forward truck, the unit fibre stress per pound of load was one pound, which reduced to 0.7 of a pound for a total load of 140,000 lbs. on the four pairs of driving wheels."

Dr. Dudley emphasizes the important element which is played by the forward truck in the distribution of rail stresses.

"The 'general depression' of the rail started by the forward truck wheels is continued under the driving wheel to the rear portion of the rail, held down by the following wheels of the tender. With this principle of distributing the loads of the locomotive, the greater weights carried upon the driving wheels do not produce a proportional increase of stress incidental to the expenditure of their tractive effort and the load carried upon the driving wheels. The rail instead of forming a deep depression under the driving wheels, is retained in a more level

and uniform height in the general depression than would be the case without the assistance of the weight upon the forward truck. In extending the same principle to larger types of locomotives, having more than two pairs of driving wheels, the effect of the distribution of the increased load of the locomotives upon stiff rails has been rendered exceedingly advantageous."

Such a study of the behavior of rails under their actual moving loads leads to valuable points to be followed in the general design of locomotives.

"For the most efficient distribution of the total load of the locomotive, the wheel base must have proper design so that the wheel spacings are not excessive. It is noticed often that the wheel spacing between the rear driving wheels and front truck wheels of the tender is so long that the rail is relieved nearly of strain under the locomotive. In such conditions, which may be observed on light rails, the engine forms a general depression, and the following tender also another depression. These are both greater than would be the case were the 'general depression' formed by the driving wheels continued to the wheels of the tender.

"The general idea that the span of the bending rail is in accordance with the tie spacing, is not confirmed. Owing to the looseness of the rails upon the cross-ties, the span of the bending rails is influenced by the wheel spacing of the locomotive, in distributing its load.

"As the stiffness of the rails has been increased, the axle loads have doubled, within the past decade. The distribution of heavy loads upon stiff rails can be made without undue injury to the track. With the increased axle load, the intensity of the pressure between the wheel tread and the head of the rail is increased. The only way to relieve this is by a slight increase in width of head, and provide for it with proper physical quantities in the metal."

ENGINEERING EDUCATION IN THE UNITED STATES.

A REVIEW OF THE PROGRESS OF THE PAST CENTURY IN THE DEVELOPMENT OF TECHNICAL EDUCATION IN AMERICA.

R. H. Fernald—Engineers' Club of St. Louis.

WHEN the present interest in technical education is taken into account, both in Great Britain and in the United States, it is a matter for congratulation that the growth of engineering education in the United States has been so fully set forth as is found in several recent publications. Among these we may note the paper presented by Mr. R. H. Fernald before the Engineers' Club of St. Louis, and published in the *Journal of the Association of Engineering Societies;* and some abstract of this is given here as forming an interesting contribution to a vital matter in national progress.

The earliest institution giving an engineering training in the United States was the United States Military Academy at West Point, but this was limited in its scope as being restricted to those only who were preparing for the government service. The University of Virginia, founded by Jefferson in 1818, was planned to have a school of technical philosophy as well as of manual training, but the first engineering school in the modern sense of the term was the Rensselaer Polytechnic Institute, at Troy, N. Y., which graduated the first class of civil engineers, not only in the United States, but in any English-speaking country, in the year 1840.

With the development of the country came an increased demand for engineering ability, and other educational institutions established technical schools. The Lawrence Scientific School, of Harvard University, the third to introduce the study of engineering, failed to realize its great opportunity, and is only now beginning to recover its lost ground. The Sheffield Scientific School of Yale University was established in 1847, but did little before 1859, and with the coming of the civil war all the technical institutions found their work much disturbed. At this time, however, came the important matter of the Land Grant Bill, by which a certain portion of the public lands was alloted to each State for educational purposes, and the principal result of this act was the founding and de-

velopment of Cornell University, the State of New York, through the wise management of Mr. Cornell, realizing far greater benefit from this source than any of the others. In Boston the Massachusetts Institute of Technology, under the able administration of Professor Rogers, did much to raise the standard of technical education, while after the war the engineering school of the University of Michigan, and the School of Mines of Columbia University entered upon the field.

Mr. Fernald gives numerous statistics in his paper to show the growth of the various engineering courses in the different institutions, and these show in a very interesting manner the influence of general affairs upon the attendance and the classification. The entrance of electrical engineering into the field with the older branches of civil, mechanical, and mining engineering is noteworthy, showing as it does how readily the institutions which were properly organized could admit into their curriculum any new and important subject, while the steady growth of all departments of scientific education, and shown by curves in diagrammatic form, is clearly indicated.

Believing that the best criterion of the work of any institution is found in the subsequent career of its graduates, Mr. Fernald shows that to-day the technically educated man of ability is looked upon with favor in the business world. The very fact that he has had to apply himself more closely and finds his course of training more rigorous than in the older courses for corresponding training in law, medicine, or similar professions, has tended to place the work of the engineer upon a basis not only commanding respect, but making the profession a learned profession in the highest sense.

Speaking broadly of the existing technical and engineering schools of the United States, Mr. Fernald says:

"The results of the excellent work of these progressive institutions are readily seen in the great engineering feats of the past few years, in the growth and prosperity due to such achievements, in the accomplishments due to engineering training in our recent war, and one need only trace these results to their sources to be convinced that the engineering school of to-day is a powerful factor in a nation's civilization and development, as well as in the general progress of the world. For the men who are achieving these results are men whose earnestness of purpose and appreciation and respect for the laws governing existing conditions have been guided and strengthened by these institutions—institutions whose aim has been to develop serious thought, power to weigh facts, ability to probe the reasons and laws producing given conditions, a true respect for the opinions and judgment of others—a comprehension of facts and conditions as they exist to-day, and the power so to modify, improve or take advantage of these facts that new and better conditions and opportunities shall be open to him who enters the world to-morrow."

PORTABLE APPLICATIONS OF ACETYLENE.

THE USE OF SOLUTIONS OF ACETYLENE IN ACETONE FOR ILLUMINATING AND HEATING APPLIANCES.

A. Janet—Le Génie Civil.

WHEN the brilliant illuminating power of acetylene gas was first made public many predictions were made as to the great value which would follow from its applications for purposes of train lighting and similar service, the idea being to use the conveniently portable liquefied gas. The dangerous character of the liquid acetylene soon became apparent, however, and after several disastrous explosions the use of the liquefied gas was abandoned. At the present time the use of acetylene in train lighting is mainly limited to the enriching of oil gas and similar purposes, and the other uses of the gas have not developed as might have been expected.

Among the early propositions to use the gas in some more secure manner, the plan of MM. Claude & Hess to employ the property of acetone as a solvent for the gaseous acetylene appeared to offer possibilities, but until recently this ingenious plan has not been

extensively employed. Now, however, it has been revived, and there is every reason to believe that it will come into use. From a paper by M. A. Janet, in a recent issue of *Le Génie Civil* we abstract some account of recent experiences in France with the dissolved acetylene, and the success which has there been attained should lead to numerous applications elsewhere.

The researches of MM. Claude & Hess demonstrated the following facts:

At ordinary pressures liquid acetone is capable of dissolving twenty-four times its own volume of acetylene, and this quantity increases in direct proportion to the pressure.

As acetone is an exothermic substance, while acetylene is endothermic, a balance is established between the emission and absorption of heat, and the system remains exothermic and therefore nonexplosive, unless the proposition of acetylene exceeds certain well-defined limits.

It is therefor practicable to store acetylene in vessels already filled with acetone, to a much greater degree than would otherwise follow from the law of Mariotte, and yet avoid any risk from possibility of explosions. The difference between acetylene liquefied by pressure and acetylene dissolved in acetone is similar to that between liquid carbonic acid and the carbonic acid dissolved in a carbonated water, as in the well-known siphons.

At the present time vessels containing solutions of acetylene are supplied commercially in France, and M. Janet discusses the methods of applying the gas so supplied for various technical purposes.

In order to avoid the formation of compressed acetylene gas in the upper portions of the cylinders, the suggestion of M. Le-Chatelier has been followed, and the receivers are filled entirely with a solid mass of porous substance, the voids of which constitute a system of capillary spaces in which explosions cannot be propagated. In steel cylinders thus filled with porous matter together with liquid acetone, it is possible, with a limiting pressure of 10 kilogrammes per square centimeter, to enclose 100 volumes of acetylene. When the outlet valve is opened there is a regular and continuous discharge of acetylene without the production of any void in the vessel. Such cylinders have now been in regular service for five or six years without the occurrence of any sort of accident, showing the entire safety of the system.

The applications of such vessels of stored acetylene are numerous, and some of them are described by M. Janet at length. Naturally the employment of the gas for train lighting is the first which suggests itself, and in such service especially the necessity of freedom from explosions is most essential. The safety of the dissolved acetylene for this purpose has been shown in various ways.

Last winter a station at St. Petersburg was destroyed by fire, and in the building were several cars containing cylinders of stored acetylene; and after the fire the cylinders were recovered intact. Similar examples have been observed on shipboard, the stored gas being recovered complete from disastrous fires, and no explosion having occurred.

M. Janet refers especially to the convenience of the dissolved acetylene for use with the acetylene-oxygen blowpipe, to which reference has already been made in these columns.

The idea of substituting acetylene for hydrogen in the blowpipe and thus obtaining a very high temperature for use in the arts, is by no means new, but various difficulties have appeared in the practical application of the idea. If the jet is so arranged that the acetylene becomes heated before reaching the point of combustion, the gas is decomposed into hydrogen and carbon, and a deposit of solid carbon forms upon the jet, tending to form a serious obstruction. Under such conditions the hydrogen alone burns, and an ordinary oxy-hydrogen blowpipe is obtained, the hydrogen being supplied by the expensive process of decomposing acetylene. In order to sesure the correct combustion the jets should be entirely separate, and the acetylene should be lighted first, with the production of a long yellowish-white smoky flame. The oxygen then being slowly turned on, produces a violent commotion in the flame, which gradually forms itself into two zones; one being highly luminous, concentrated at the base of the flame, while the other of a pale red, hardly visible, occupies the point. The supply of a very small addi-

tional proportion of oxygen completes the adjustment; the flame becomes almost silent, projecting a long, almost colorless flame at the base of which is a sort of pencil of fire. The long flame is the hydrogen set free from the acetylene, and burning in contact with the air, while the pencil of fire is the true oxy-acetylene jet, in which exists the most formidable elevation of temperature which has yet been artificially produced.

For all the purposes to which the oxy-blowpipe are already numerous, and will doubtless become greatly extended as experience is had in its use. All the metals used in the arts may be welded by its heat, without the employment of any intermediate material. Broken connections may be repaired and defective pieces mended. Electrical connections may be made with certainty that the conductivity has not been impaired, and everything which includes the fusion of definite areas may be effected with convenience and certainty.

For all the purposes to which the oxy-acetylene blowpipe are adapted the use of dissolved acetylene is applicable, and the essential element of portability, combined with perfect safety renders it the most satisfactory method of carrying one of the elements of the apparatus. Compressed oxygen is already available, and being in itself non-combustible and non-explosive, needs no modification to adapt it to the practical requirements of the workshop and the field, so that both of the materials required for the application of the new tool are to be had. Under such conditions there is every reason to believe that the new source of high temperatures will become a tool in general use, and will be found not only in the workshop, but also in the field, the shipyard, and the bridge site.

THE UTILISATION OF WASTES.

CAUSES OF SUCCESSES AND FAILURES IN THE COMMERCIAL RECOVERY OF VALUABLE PRODUCTS FROM MANUFACTURING RESIDUES.

Engineering.

IT was Dr. Samuel Johnson, we believe, who first defined a weed as a plant whose value had not yet been found out. In like manner many products have been permitted to go to waste because their value was not known, and much of the skill of modern chemistry and technology has been devoted to the recovery of such by-products as have been found profitable of treatment.

In a recent paper in *Engineering* the subject of the utilization of wastes is discussed, and it is shown that some of the more promising schemes for the recovery of value from residues have failed from reasons which might well have been understood in advance. At the same time there have been notable examples of the production of great values from most unpromising material, so that the whole question is one which demands the combined skill of the scientist and the business man if mistakes on either hand are to be avoided.

It is not so very long ago that phosphorus in iron was considered a most serious defect, but with the advent of the basic steel process and the realisation of the value of basic slag as a fertilizer this point of view has been wholly reversed. Again a portion of the heat which passes off in the discharge gases of a blast furnace has been utilised for a long time for heating the blast and for steam making in connection with boiler installations, but it is only within the past few years that the possible utilisation of the whole gaseous output of a furnace directly in internal-combustion engines for the generation of power has been appreciated.

Of course a large number of by-product recovery processes are found in connection with the various chemical industries, and these lend themselves readily to such economies, especially as the necessary professional skill to devise the best methods is generally available. It is just here, however, that familiarity with the commercial side of the question becomes of importance. The scientific man may feel sure that he has devised a method for the recovery of a valuable waste product, while the manufacturer knows well that it is cheaper to allow the material to run to waste than it is to incur the expense involved in its recovery. Very often the first cost of installation of

the necessary plant includes a fixed charge which will continue to remain fixed while the methods of manufacture may be so modified as to render the process useless. Changes are frequent in the chemical industries, and a product may yield a good profit one year and involve the manufacturer in a loss the next. Apart from the direct technical and commercial features of the question there are often collateral points to be considered. Among these the cost of transport and the influences of competition must be taken into account, since in some instances a by-product which may readily be recovered cannot be placed in the market to advantage for commercial reasons which do not at first appear to the engineer or the purely technical man.

The state of the market, and its possible vicissitudes should also be considered before any important waste-recovery project is undertaken.

"A few years ago, it was proved to be practicable and economical for india-rubber manufacturers to recover the naphtha used in bringing the rubber into solution. This year, however, owing to certain causes, solvent naphtha has been contracted for at a price less than half of that which used to be considered the normal price. Under the circumstances, it is not surprising that the makers of naphtha-recovery plants are not busy. In a good many cases chemicals are run to waste which cound be profitably recovered by the chemical manufacturer, were it not for the matter of freight. The cost of carriage on the liquor from dye-works, or calico-printing works, is quite prohibitive in most cases; and unless there is inclination and the necessary facilities for working them up on the spot, they are perforce allowed to run to waste.

"A by-product business which has now been largely given up on account of the reduced selling price of the material is that of the preparation of copperas, or sulphate of iron, from coal-measure pyrites. This body, which occurs in some coal seams to a considerable extent, has to be removed as far as possible from the coal, and when copperas sold at 60s. per ton, it was the regular thing to make it from the pyrites by oxidation. To some extent this is still carried on; but, as a rule, in the North of England, the process has been given up since the selling price of the product dropped to about half the above figure. Recovery processes, or methods for the utilisation of waste, will be adopted or, more correctly speaking, carried on, only as long as the current market quotations for the products enable them to be worked at a profit; and, though this seems to be merely the statement of a truism, it is necessary to emphasize it in order to explain away the great disparity observable between the number of processes worked out theoretically, and probably patented, and the number found in actual operation."

All these facts emphasize the importance of the joint operation of the chemist, the engineer, and the business man in the consideration of the installation of any important plant for the recovery of by-products on a large scale. Thus the engineer is perfectly convinced that all the gases from a furnace plant can be used for the generation of power in gas engines. Apart from the demands for power in connection with the blowing engines, hoisting machinery, and other power requirements of the furnace plant, however, there is no immediate demand for all the large amount of power thus capable of development. It is altogether possible to have the powerful gas engines thus supplied with fuel, arranged to generate electric current, but unless there is an immediate market for electricity supply in the vicinity of the furnaces, the costs of transmission to suitable localities must be taken into account, together with the commercial end of the disposal of the electrical energy, either for lighting or for power purposes. All this means that establishments already organized for the purpose of manufacturing iron shall add to this a new undertaking, namely that of generating and vending electrical energy, entering into competition with existing establishments and generally branching out into fields foreign to their present work. In many instances this may be warranted and profitable, but in others it may be so much of an experiment as to demand most careful investigation and a thorough balancing of conditions before a correct judgment can be rendered. The utilisation of wastes is all right, but it is important to make sure that there is a field for the use of the wastes before the mechanism for their saving is put into operation.

ENGINEERING AND CHEMISTRY.

THE INTERRELATION BETWEEN TWO KINDRED PROFESSIONS AND THE POSSIBILITIES RESULTING FROM THEIR HARMONIOUS CO-OPERATION.

Prof. W. Ostwald—Verein Deutscher Ingenieure.

AT the recent convention of the *Verein Deutscher Ingenieure,* a notable feature of the meeting was an address by Professor Dr. Ostwald, the well-known chemist, upon the relations which exist, or should exist, between the two professions of engineering and chemistry. The address is published in full in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure,* and some abstract is here given.

Referring in an introductory manner to the general influence of applied science upon the welfare of mankind, Dr. Ostwald showed that while the human race had existed and flourished for thousands of years without the benefits of science, yet the direct advantages of the progress of recent years upon human health, comfort, and wealth have been most marked. In this work all the different departments of science have had an active share, and many of the most important developments have been due to the united action of different branches.

Without enumerating a long list of subjects in which the work of the chemist has become allied with that of the engineer, we may note directly the progress which has been made in the employment of chemical methods in connection with the study of materials of construction, in the examination of ores and of metals, and in the verification of results of combinations. The relations of the recent science of electrochemistry to engineering in general are also to be noted, since to it we must look for much of the possible development of electrical engineering, including the improvement of the accumulator, and similar work.

An important portion of the work of the mechanical engineer bears a close relation to the science of chemistry, since the reactions involved in the scientific utilization of fuels are essentially of a chemical nature. Thus the efficient combustion of fuels, the prevention of smoke, the study of waste furnace gases, and the like, demand a knowledge of chemistry for their successful prosecution, and much of the progress which has been made in this work is due to the associated work of the chemist and the engineer.

It is in this line that still further progress is to be expected. The development of the heat engine as a source of motive power is generally understood to be along the line of the internal-combustion motor, and this requires a union of the application of the principles of thermodynamics and the chemistry of gas production. Dr. Ostwald especially discusses the importance of the use of the principles of theoretical chemistry in the design of gas producers for various fuels. Thus it is possible to use the low-grade brown coals and lignites, or even peat as a cheap fuel, producing gas suitable for application in the most efficient manner in large gas engines similar to those designed for the utilisation of blast-furnace gases. By employing properly designed gas-producers the fuel may be gasified at moderate temperatures with a minimum loss of heat and a maximum degree of efficiency.

The technical applications of water gas are also of great importance, both in connection with illumination and as a fuel for power and metallurgical purposes, and great improvements in its efficient generation have resulted from the application of correct chemical principles to the practical processes. With all of these processes come the associated operations for the recovery of valuable by-products, some of which often rank in commercial value nearly with the principal product of gas or of power.

All these elements unite to make the establishment of central gas producing stations most essential for the attainment of the highest commercial efficiency. In this way the cheapest solid fuels may be converted into the most convenient and efficient gaseous fuel, both for power generation and for heating purposes. The gas engines may be associated with the same central plant, and the energy electrically transmitted to the numerous points of application. All the by-products may also be recovered

to the maximum advantage and delivered to the accompanying chemical works. Included in the gas generating plant should be an installation for the fixation of the nitrogen contained in the gas and its reduction to the forms required for agriculture as fertilisers. The process due to Dr. Ostwald himself enables the gas-tar ammonia to be converted into ammonium nitrate, thus furnishing a richer fertiliser than is found in sodium nitrate.

In connection with the discussion of the importance of the joint work of the chemist and the engineer, Dr. Ostwald made a contribution to the much discussed subject of technical education and its influence upon professional and commercial progress. In England as well as in America it is generally assumed that the technical education available in Germany is of the highest order, and that to this cause is due much of the rapid progress which she has made in applied science. Among German professional men, however, there is believed to be room for much improvement in educational methods. It is manifestly impracticable to unite the technical high schools with the universities, as the latter are at present constituted, and any radical change in the university system of Germany is not considered. At the same time it is not impossible that the technical high schools may become associated together in their work and thus each strengthen the other. That this desirable end may be attained it is important to encourage the development of technical and engineering laboratories, so that the work of the technical student may be directed towards independent investigation and study under the general guidance of his professors and instructors, and thus the methods of the technical school become assimilated to some extent to that of the university.

TANGENTIAL WATER WHEEL EFFICIENCIES.

AN EXPERIMENTAL INVESTIGATION INTO THE RELATIVE VALUES OF DIFFERENT BUCKET SHAPES FOR IMPACT WATER-WHEELS.

G. J. Henry—Pacific-Coast Electric Transmission Association.

IN designing water wheels of the impact type, of which the well-known Pelton wheel is a conspicuous example, the form of the bucket against which the jet of high-pressure water impinges has a most important influence upon the efficiency. Various theories have been developed for the solution of this problem, and numerous experiments have also been made. The latest series of experiments are those described in a paper presented before the Pacific Coast Electric Transmission Association by Mr. George J. Henry, Jr., and the results of his investigations are of sufficient importance as to be considered a valuable contribution to this department of hydraulic engineering.

In the first place Mr. Henry calls attention to the fact that while it is most important, the bucket shape is but one element of several which influence the efficiency of the machine.

"To obtain the best efficiencies it is necessary to have the proper pipe line, gate valves, nozzles, water wheels and buckets, wheel case, wheel pit and tail-race, and all of these parts must be properly designed for the particular conditions under which they are to operate, and all will vary with the head or pressure—the water quantity and the revolutions which the wheel is to make. Many a water wheel bucket has been overworked for years, and then charged up with losses that occur because of its being improperly worn, due to this overwork. Again, buckets are frequently charged up with all kinds of losses which are really due to something for which the bucket is not responsible. Pressure, or wheel diameter, or speed on a given wheel, cannot be varied radically without materially altering the efficiency. Many hydraulic plants are in operation and developing not over 65 per cent. between the flume and water wheel shaft where the *bucket* itself is capable of developing 90 per cent., and where a very inexpensive change could be made which would increase the gross efficiency very materially and cause a great saving in the water bills."

The bucket of an impact tangential water wheel is so shaped as to receive the stream

centrally and divide it in such a manner as to discharge the water with the minimum resistance, the energy of the stream being transferred to a maximum degree to the wheel itself. The direction of the discharge is naturally governed to a great extent by the form of the bucket, and it was to investigate the effect of various forms of buckets that the experiments described by Mr. Henry were conducted. Accepting the view that the best possible bucket efficiency is obtained when the water jet is taken up on the bucket surface, and brought to rest as nearly as possible with the least loss of energy, Mr. Henry analyzes the necessary losses as made up of the following elements:

1. The discharge velocity with which the water leaves the bucket with respect to a point fixed in space. Note that this velocity will vary with every position of the discharge as bucket moves.

2. Air and surface friction inside the bucket.

3. Imprisoned water in the bucket.

4. Variation in the stream form, producing erratic conditions of impact and flow on the bucket surface.

5. That occasioned by the stream being displaced by the entering bucket.

6. Eddy currents in the buckets.

7. Water which does not give up all its energy to the bucket.

Apart from any experimental considerations, Mr. Henry first considers the points upon which the most efficient bucket may be designed, as follows:

"Given a certain stream of water at a given spouting velocity, it is advisable that this be taken upon the bucket surfaces of just enough buckets to catch every particle of water on the dividing wedges and turn it all on the curved surfaces, and discharge it at just enough velocity (and entirely in a direction at right angles to the entering stream axis) to clear the next following bucket. This resulting velocity will be the tangent of the discharge angle, multiplied by bucket velocity.

"The air and surface friction must be maintained as small as possible by the use of a nozzle which will give a perfectly circular and solid stream. The bucket surface and cutting edges must be of a shape which, with a minimum wetted surface, will allow the steam, without crowding at any point, to spread out in a thin fan-like discharge on each side. The surface must be such that the water will not adhere, and as smooth as possible.

"The surface may be ground and polished, or better, ground and well painted with a special compound. If all of these points are carefully studied out and the front of the bucket properly shaped and not cut away too low, the imprisoned water will not cause any appreciable loss.

"The windage will also be a minimum if the number and surface of the buckets is a minimum."

The experimental plant used by Mr. Henry included a wheel with removable buckets, enclosed in a plate-glass case, and illuminated by an arc light in such a manner that the whole could be photographed while in action. The result is an exceeding interesting series of photographs, showing clearly the manner in which the jet is received and discharged under different conditions. With this was included a Prony brake for determining the power developed, and accessory measuring apparatus for determining the water consumption, so that all the elements for determining the efficiency of any particular arrangement were present, besides the opportunity of seizing the visual appearance of the jet and the discharge.

For the details of the results of the experiments with the different buckets tested reference must be had to the original paper, but the principal conclusion deduced from all the trials is one in which every thoughtful engineer will agree, namely, that it is impossible to get equally good results from a certain shape of bucket under all the various conditions of wheel and stream diameter and water pressure, but that to get the best efficiency a bucket must be designed for each set of conditions. Theoretical investigations, in which frictional resistances in the bucket, as well as air and other losses are neglected, must necessarily give results at variance with the conditions in actual practice in which all these resistances are necessarily included. The water wheel designer must take into account all the conditions there are, and cannot afford to neglect any element which goes to make up the total efficiency.

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING	123	MARINE AND NAVAL ENGINEERING	139
ELECTRICAL ENGINEERING	128	MECHANICAL ENGINEERING	141
GAS WORKS ENGINEERING	135	MINING AND METALLURGY	148
INDUSTRIAL ECONOMY	138	RAILWAY ENGINEERING	152

STREET AND ELECTRIC RAILWAYS 154

CIVIL ENGINEERING

BRIDGES.

Arch.

A Contribution to the Study of the Semicircular Arch (Beitrag zur Untersuchung des Halbkreisförmigen Bogenträgers). G. Ramisch. An investigation of the distribution of stresses for various loadings of a semicircular arch, hinged at the springings. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—July 3, 1903. No. 57326 D.

Blackwell's Island, N. Y.

The Specifications for the Superstructure of the Blackwell's Island Bridge. Lengthy abstract of these specifications, without comment. 3300 w. Eng Rec—Aug. 22, 1903. No. 57531.

Bridge Terminal.

Proposed Brooklyn Bridge Terminal and City Offices. Henry F. Hornbostel. An illustrated general outline of extensive improvements planned, which will cost $50,000,000, when fully carried out. 1300 w. Archt & Build's Mag—Aug. 1903. No. 57096 C.

Cantilever.

Cantilever Bridge at Connel Ferry. Illustrated description of a bridge in Scotland having a clear span of 500 ft. Gives also an account of the construction work.

We supply copies of these articles. See page 157.

3300 w. Engng—July 31, 1903. No. 57-126 A.

Early and Curious Types of the Cantilever Bridge in New England and New Brunswick. Alfred W. Parker. Illustrated descriptions of bridges built previous to 1870, with particulars of their construction. Also discussion. 3800 w. Jour Assn of Engng Socs—July, 1903. No. 57-451 C.

The Wabash Bridge at Pittsburg. An illustrated description of the cantilever bridge over the Monongahela River, which completes the Wabash extension into Pittsburg. It has a truss span of 812 ft. between pier centers, and is designed to carry the heaviest loads. The steel eyebars used are the strongest ever made. 1300 w. R R Gaz—Aug. 14, 1903. No. 57267.

Highway.

The Great Miami River Highway Bridge, Dayton, Ohio. Illustrated description of a reinforced concrete arch bridge, 56½ ft. wide, and 588 ft. long. 1500 w. Eng Rec—Aug. 8, 1903. No. 57192.

Old Bridge.

Old Railway Bridge Over the River Gaundless. Illustration, with brief account of an old bridge in England, recently replaced by a modern structure. 600 w. Engng—Aug. 14, 1903. No. 57493 A.

Plattsmouth.

The Plattsmouth Bridge of the Burlington. An illustrated account of the rebuilding of this bridge across the Missouri River. 1000 w. R R Gaz—Aug. 7, 1903. No. 57162.

Suspension.

The New Manhattan Bridge. A discussion of the proposed change to wrought steel chains instead of steel wire cables. 1800 w. Engr, Lond—Aug. 14, 1903. No. 57498 A.

Viaduct.

Erection of Manhattan Valley Viaduct. An illustrated account of the erection of a three-track plate-girder structure, 2,174 feet long, with a maximum height of about 54 ft., for the N. Y. Rapid Transit R. R. 1700 w. Eng Rec—Aug. 8, 1903. No. 57190.

Widening.

The Widening of London Bridge. Harold J. Shepstone. Illustrated description of the widening of the foot-paths. The method is interesting on account of the conditions under which the work is carried on. 1200 w. Sci Am Sup—Aug. 1, 1903. No. 57052.

CANALS, RIVERS AND HARBORS.

Docks.

The Bush Docks in Brooklyn. An illustrated account of this terminal for ocean steamships, which seems highly satisfactory to both ship owners and freight agents, and all interested. 1800 w. Ry & Engng Rev—Aug. 15, 1903. No. 57247.

Dover Harbor.

The National Harbor at Dover. Archibald S. Hurd. An illustrated description of the construction of the greatest artificial harbor in the world. 3800 w. Cassier's Mag—Aug., 1903. No. 57284 B.

Electric Dredge.

See Electrical Engineering, Power Applications.

Lighthouse.

See Electrical Engineering, Illumination.

Ore Dock.

A Large Ore Dock at Escanaba, Mich.; Chicago & Northwestern Railway. An illustrated description of the new dock, No. 6, which takes the place of the old No. 2 dock. 1400 w. Eng News—July 30, 1903. No. 57041.

River Improvement.

Waterway Improvement on the Ohio. William Gilbert Irwin. An account of important improvements made and projected with a view to increasing its facilities as a commercial stream. 2000 w. Sci Am—Aug. 15, 1903. No. 57195.

Sea Wall.

The Failure of a Sea Wall and Its Reconstruction. Clarence T. Fernald. An illustrated account of the failure of the old wharf at East Cambridge and the construction of the new sea wall. General discussion. 2500 w. Jour Assn of Engng Socs—June, 1903. No. 57447 C.

Susquehanna.

The Navigation of the Susquehanna River, and the Beginnings of the Reading Railroad. Williard T. Block. Reviews the early attempts to navigate this river, and the disaster that led to the construction of a canal; and the first railroads of Pennsylvania. 1000 w. R R Gaz—Aug. 7, 1903. No. 57164.

Tides.

Large Ebb and Flow in Harbor. George H. Waring. An illustrated article explaining the advantage taken of the large ebb and flow of the tide in the harbor of St. John, N. B., Canada. 900 w. Marine Engng—Aug., 1903. No. 56891 C.

CONSTRUCTION.

Foundations.

Boston Foundations. Joseph R. Worcester. A discussion confined to ordinary structures not requiring excessively large foundations, considering the best way to pile, what loads it is safe to place on piles, what grade piles should be cut, how foundation piles should be capped. Map, and

general discussion. Ill. 22000 w. Jour Assn of Engng Socs—June, 1903. No. 57445 C.

Concrete Foundations. R. P. King. Practical hints for builders of machinery foundations. Ill. 3000 w. Mach, N. Y.—Aug., 1903. No. 57078 C.

Foundations for the Elevated Structure of the Boston Elevated Railway. George A. Kimball. Illustrated detailed description. 1800 w. Jour Assn of Engng Socs—June, 1903. No. 57448 C.

Foundations. George B. Francis. Considers the need of obtaining all possible information, discussing borings, piles, grillage, riprap, footings, concrete, etc. General discussion. 2200 w. Jour Assn of Engng Socs—June, 1903. No. 57446 C.

Highways.

Planning a New York-Chicago Highway. Robert Bruce. Reviews the history of various road enterprises and outlines the route most in favor for the construction of a national highway. Maps. 3500 w. Automobile—Aug. 1, 1903. No. 57059.

New York Subway.

Section Nine of Division Three of the New York Rapid Transit Railroad. Illustrated detailed description of open trench construction is given in the present article. 3500 w. Eng Rec—Aug. 22, 1903. Serial. 1st Part. No. 57528.

Roofing.

Roofing Existing Shops While Work is Proceeding. R. H. Fowler. An illustrated description of a method of re-roofing shops without interfering with work. 1400 w. Inst Mech Engrs—July, 1903 No. 57123 D.

Tunnels.

A Brief Account of Recent Large Tunnel Works. Editorial on the extent of this work in Continental Europe. 1800 w. Eng News—Aug. 13, 1903. No. 57275.

London's "Tubes"—The Novel Method of Their Construction. Describes the novel features of the four tubes in process of construction. Ill. 2200 w. Sci Am Sup—Aug. 22, 1903. No. 57295.

The Construction of the Simplon Tunnel. The present article gives the history of the project, explaining the relation of the tunnel to existing routes, and describing engineering features of connecting lines. Ill. 3500 w. Eng News—Aug. 13, 1903. Serial. 1st part. No. 57271.

The Hudson River Tunnel. An interesting illustrated article giving history and description of work of construction of the tunnel which is to give communication between the trolley sytems of New York and Jersey City. 1700 w. Sci Am —Aug. 22, 1903. No. 57294.

The Simplon Tunnel (Der Simplon-durchstich). H. Baum. A general description of the work with numerous illustrations showing the methods and progress down to the close of 1902. 7000 w. 2 plates. Glückauf—July 18, 1903. No. 57337 D.

MATERIALS.

Brick.

The Argilo-Calcareous or Sand-Lime Brick (Girard-Meurer Process). From *Stone Trades Journal.* Describes these bricks and the process of manufacture. They are composed of sand, lime and clay, hardened by means of steam under pressure. 2000 w. Am Archt—Aug. 1, 1903. Serial. 1st part. No. 57036.

Cement.

Manufacture of Cement from Marl and Clay. Discussion of paper by Henry S. Spackman. 2700 w. Pro Engrs' Club of Phila—July, 1903. No. 57454 D.

Portland Cement and Blast Furnace Slag (Portlandzement und Hochofenschlacke). Dr. H. Passow. An exhaustive study of the constitution of Portland cement, with micrographs of cements and clinker, showing the applicability of certain slags for making Portland cement. 6000 w. Stahl und Eisen—Aug. 1, 1903. No. 57334 D.

Portland Cement Manufacture. Edwin C. Eckel. In the present paper an account is given of the excavation and transportation to mill of the raw cement materials and the cost. 1400 w. Munic Engng—Aug., 1903. No. 57208 C.

Tests of Portland Cement Mortar Exposed to Cold. C. S. Gowen. Read before the Am. Soc. for Test. Materials. An account of experiments made to secure definite information on the effect of frost under the different conditions in which it may be desired to use Portland cement mortar in cold weather. Also Editorial. 2800 w. Eng News—July 30, 1903. No. 57040.

The Portland Cement Industry. Percy F. Balfour, in *Queens' Quarterly.* Reviews the history of the development of this industry in various countries. 3000 w. Can Archt—Aug., 1903. No. 57503 B.

Concrete.

A Concrete Measuring, Feeding, and Mixing Plant. Describes and illustrates the concrete apparatus of the Columbian Cordage Co., at Auburn, N. Y. 1500 w. Eng Rec—Aug. 15, 1903. No. 57260.

Effect of Water and Combinations of Sand on the Setting and Strength of Concrete. E. S. Larned. Abstract of a paper read before the Am. Soc. of Test. Materials. Reports a series of tests made by the writer, considering the results. 2200 w. Eng News—Aug. 6, 1903. No. 57160.

We supply copies of these articles. See page 157.

The Strength of Concrete as Affected by Different Percentages of Water. T. L. Doyle and E. R. Justice. Abstract of a thesis at the Univ. of Penna. Describes experimental investigations to determine the relation of strength between dry, medium wet, and wet mixtures. 800 w. Eng News—July 30, 1903. No. 57039.

Iron.

Iron. Prof. Aitchison. Some remarks on architecture and what it does for a country, and an interesting dissertation on the use of iron as a building material. Ill. 6800 w. Jour Ry Inst of Brit Archts—June 27 and July 25, 1903. Serial. 2 parts. No. 57470 each B.

Reinforced Concrete.

A Concrete-Steel Water Tower Near Boston. Illustrated description of a standpipe and tower of Hennebique armored concrete construction. 1000 w. Eng Rec—Aug. 22, 1903. No. 57530.

Comparative Tests of Beams of Reinforced Concrete (Essais Comparatifs de Poutres en Beton Armé). Data and results of tests of beams of the Maciachini type and ordinary reinforced concrete beams. 3000 w. Beton und Eisen—No. III., 1903. No. 57320 H.

Notes on Compound Structures (Einiges über Verbundkörper). Adolf Francke. A mathematical study of the combined resistance of the two materials in structures of concrete and iron. 5000 w. Beton und Eisen—No. III., 1903. No. 57318 H.

Rational Formulas for the Strength of a Concrete-Steel Beam. S. E. Slocum. Aims to develop a method of simple, rational analysis of a simple form of concrete-steel beam. 3000 w. Eng News—July 30, 1903. No. 57042.

Sixteen-Story Concrete-Steel Office Building at Cincinnati, O. An illustrated detailed description of the construction work of the Ingalls building. 5000 w. Eng News—July 30, 1903. No. 57037.

Tests upon Lattice Beams, Visintini System (Einige Versuche mit Gitterbalken, System Visintini). Illustrated account of tests of reinforced-concrete beams of the Visintini type by direct leading. 4000 w. Beton und Eisen—No. III., 1903. No. 57322 H.

Tests upon the Bond of Union between Concrete and Steel. C. W. Spofford. Tabulated report of tests made at the Mass. Inst. of Technology. The rods used were of the Ransome, Thacher, and Johnson types. 1800 w. Beton und Eisen—No. III., 1903. No. 57323 H.

The Calculations for Arches of Reinforced Concrete (Die Berechnung von Gewölben aus Eisenbeton). Dr. Max R. v. Thullie. A graphical and analytical study, showing the distribution of stresses for various combinations of iron and concrete in arch construction. 5000 w. Beton und Eisen—No. III., 1903. No. 57319 H.

The Computation of Double-Reinforced Concrete Beams (Ueber die Berechnung von Beiderseits Armierten Betonbalken). F. von Emperger. Data and results of tests of beams of concrete reinforced with iron rods near both upper and lower edges. 12000 w. Beton und Eisen—No. III., 1903. No. 57321 H.

The Construction of Flat Ceilings for Houses (Note sur les Planchers à Plafond Plat des Maisons d'Habitation). Illustrating and describing the systems of Hennebique, Boussiron, and Matrai. 2000 w. 1 plate. Beton und Eisen—No. III., 1903. No. 57316 H.

The Strasburg Music Hall (Das Sängerhaus in Strassburg). E. Züblin. Illustrated description of large auditorium and club house built in reinforced concrete. 3000 w. 3 plates. Beton und Eisen—No. III., 1903. No. 57315 H.

The Visintini System (Das System Visintini). A system of reinforced concrete beams of open lattice work of concrete with metal rods imbedded. 1800 w. Beton und Eisen—No. III., 1903. No. 57317 H.

Stone.

Quarries and Stone Working in Havana. Information based largely on the report prepared by Mrs. Harriet Connor Brown. 2500 w. Stone—July, 1903. No. 57210 C.

Testing.

The Underwriters' Laboratories. Day Allen Willey. Illustrates and describes a laboratory in Chicago for testing the utility of all fire resisting materials and systems, as well as apparatus used. 2000 w. Sci Am Sup—Aug. 22, 1903. No. 57400.

See Mechanical Engineering, Materials.

Wood Fireproofing.

Fireproofed Wood as a Building Material. Prof. Ira H. Woolson. Prepared for the International Fire Prevention Congress. Discusses the increasing use, especially in New York, of fire-resistant wood, the testing, quality, etc., the advantages and failings of the material. 4000 w. Archt, Lond—July 31, 1903. No. 57071 A.

Wood Preservation.

Preservation of Wood. Translated from *La Chronique Industrielle*. Briefly describes a number of methods in use. 2700 w. Sci Am Sup—Aug. 8, 1903. No. 57173.

MEASUREMENT.

Instrument.

The Richards Prismatic Stadia as a Range-Finder. E. K. Landis. Describes

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the use of this instrument as a range finder, giving results obtained. 1800 w. Pro Engrs' Club of Phila—July, 1903. No. 57455 D.

Slope Stakes.

A Graphical Method of Setting Slope Stakes. J. M. Rudiger. Describes a simple and effective method, giving diagram. 700 w. Eng News—July 30, 1903. No. 57043.

Tachymeter.

The Hammer-Fennel Instrument for Stadia Work. Horace Andrews. Illustrated description of the recent improvements in this instrument. 1400 w. Eng News—Aug. 13, 1903. No. 57273.

Wind Resistance.

Experiments upon the Resistance of the Air (Expériences sur la Resistance de l'Air). G. Eiffel. A review of the observations made upon the Eiffel tower in Paris, showing the variations of the coefficient for different surfaces. 1200 w. Comptes Rendus—July 6, 1903. No. 57341 D.

MUNICIPAL.

Baths.

The Karl Müller Public Baths (Les Bains Publics Karl Müller). An illustrated description of handsome new public bath buildings at Münich, Bavaria. 1500 w. 1 plate. Génie Civil—July 18, 1903. No. 57308 D.

Boulevard.

The Grand Boulevard and Concourse, New York City. Map, cross-section, and description of the concour e which will connect Central Park with the park system north of the Harlem River. 1800 w. Eng Rec—Aug. 8, 1903. No. 57191.

Fire Losses.

The Prevention of Loss by Fire in the United States of America. Edward Atkinson. Prepared for the International Fire Prevention Congress. Calls attention to the different conditions which govern architecture in the United States, as compared with European states; discusses the construction of towns and cities, and their needs, and general conclusions in regard to fire protection. 7000 w. Am Archt—Aug. 8, 1903. No. 57097.

Municipal Vehicles.

See Mechanical Engineering, Automobiles.

Pavements.

Bitulithic Pavement in Nashville. W. W. Southgate. Discusses the principles of its construction and its points of excellence. Ill. 1500 w. Munic Jour & Engr—Aug., 1903. No. 56899 C.

Brick Pavements at Syracuse, N. Y. An illustrated article reporting the amount of brick pavement laid, its cost, and condition after ten years' wear. 2000 w. Brick—Aug., 1903. No. 56871.

Refuse.

The Horsfall Refuse Destructor and Forced Draught System. Information of results obtained with this type of destructor. Ill. 1400 w. Elec Rev, Lond—July 31, 1903. No. 57117 A.

Sewage.

On the Distribution of Sewage on Bacteria Beds. John C. Thresh, and Martin Priest. Abstracted from a paper read before the Inst. of San. Engrs. A discussion of the best means for the distribution. 1500 w. Engr, Lond—July 24, 1903. No. 57032 A.

Sewage Pollution of Water Supplies. Editorial review of recent court decisions. 1600 w. Eng Rec—Aug. 1, 1903. No. 57094.

The Royal Commission on Sewage-Disposal. Reviews the third report of the Commissioners, the evidence already accumulated and conclusions as to methods which may be properly adopted. 3500 w. Builder—July 25, 1903. No. 57010 A.

Sewers.

The High-Level Sewer of the Metropolitan Sewerage District of Massachusetts. John S. Hodgson. Map showing the various systems of sewers and profile of the outfall pipe of the high-level sewer, with descriptive notes. 1800 w. Ill. Eng Rec—Aug. 15, 1903. No. 57259.

Street Cleaning.

Street Cleaning in San Francisco. L. M. King. Gives a resumé of the methods employed under the present system, with the results. 1200 w. Eng News—Aug. 20, 1903. No. 57542.

Trenches.

The Back Filling of Trenches. W. F. Raymond. Gives the writer's views of the best method. 1400 w. Munic Engng—Aug., 1903. No. 57209 C.

WATER SUPPLY.

Anchor Ice.

Experience with Anchor Ice at the Detroit Water-Works and Elsewhere. C. W. Hubbell. From the Michigan *Technic* for 1903, Univ. of Mich. Describes anchor ice difficulties and attempted remedies. 4300 w. Eng News—Aug. 13, 1903. No. 57276.

Atlantic City.

The Water-Works of Atlantic City, N. J. Illustrates and describes a system designed to meet unusual conditions, and give fire protection to about 700 hotels, mostly constructed of wood. 2500 w. Eng Rec—Aug. 22, 1903. No. 57529.

Australia.

Water for the Gold Fields of Western

Australia. D. M. Bates. An illustrated account of the great engineering feat to furnish water for the Coolgardie and Kalgoorlie gold fields. 3500 w. Cassier's Mag—Aug., 1903. No. 57279 B.

Filtration.

Ferrous Sulphate as a Coagulant in the Mechanical Filtration of Water. Ernest E. Irons. Describes the plant at Quincy, Mass., where solutions of ferrous sulphate and lime water in the proper proportions, are added to the water, with resulting coagulation followed by rapid subsidence. 2500 w. Eng Rec—Aug. 8, 1903. No 57193.

Protection of Gathering-Grounds and Filtration Compared. Prof. S. Delépine. Summary of a paper read at the meeting of the British Assn. of Water-Works Engrs., with editorial. A comparison as to which system possessed the greater merits, favoring protection of sources of supply. Editorial disapproval and discussion. 5000 w. Jour Gas Lgt—Aug. 11, 1903. No. 57292 A.

Fire Protection.

Fire Protection Water Works. Nicholas P. Simin. Describes American and Russian practice. Ill. 2500 w. Munic Jour & Engr—Aug., 1903. No. 56898 C.

Irrigation.

Drainage of Irrigated Lands. Ernest McCullough. Shows how drainage practice in the West varies from accepted practice in the East, and why. 3300 w. Eng News—Aug. 20, 1903. No. 57540.

Masonry and Steel Head-Gate of the Grand Valley Irrigation Canal, Colorado. Clarence T. Johnson. Illustrations, with brief description. 700 w. Eng News—Aug. 13, 1903. No. 57274.

Jerome Park, N. Y.

Report of the Commission of the Jerome Park Reservoir. Report on the condition of the walls, discussing the water-tightness of the retaining walls and the best methods of securing a water-tight bottom of concrete, and the use of stone dust in the place of sand and mortar. 5400 w. Eng News—Aug. 6, 1903. No. 57161.

Jersey City.

The New Water-Works of Jersey City. An illustrated article giving information of work on the Boonton dam of the Jersey City water-works, and detailed description. Also describes the building of the core wall at the Parsippany dyke. 4800 w. Eng Rec—Aug. 8, 1903. No. 57189.

Microscopy.

The Value of Microscopical Study in the Selection of Water (Die Bedeutung der Mikroskopischen Untersuchungsmethode für die Beurteilung des Wassers). Dr. G. Lindau. Emphasizing the importance of a continual study of a drinking water supply by microscopical examination. 2500 w. Gesundheits-Ingenieur—July 20, 1903. No. 57332 B.

Philadelphia.

Improvement, Extension, and Filtration of the Water Supply of Philadelphia. John W. Hill. An illustrated article describing work in progress and calling attention to features of interest. General discussion. 17300 w. Pro Engrs' Club of Phila—July, 1903. No. 57453 D.

Pipe Cleaning.

A New Pipe-Scraping Machine. C. C. Smith. Abstract of a paper read before the British Assn. of Water-Works Engrs. Illustrated description of a machine which will successfully cleanse pipes under 4-in. in diameter. The invention of a German, Mr. Nowotny. 1000 w. Ir & Coal Trds Rev—July 24, 1903. No. 57033 A.

Town Supply.

Water Supply Engineering for Towns. P. Byrne. Read before the Engng. Assn. of the South. Discusses briefly points to be considered when water-works become a necessity. 2200 w. Munic Jour & Engr—Aug., 1903. No. 56897 C.

Water Tower.

See Civil Engineering, Materials, Reinforced Concrete.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cuba.

The New Cuban Telegraph Service. Charles Minor Blackford. Maps showing old and new lines, with explanatory notes. 700 w. Sci Am Sup—Aug. 22, 1903. No. 57298.

Pacific Cable.

The Pacific Cable. Reviews the various attempts to give cable communication across the Pacific, and the final success, discussing the importance of the event. 2000 w. Gunton's Mag—Aug., 1903. No. 56864.

Space Telegraphy.

Hertzian Wave Telegraphy. Dr. J. A. Fleming. Cantor lectures. The first lecture of a series on the variety of tele-

graphy without continuous wires, in which Hertzian electric waves are employed; deals with the appliances used and the theory of their operation. 11500 w. Jour Soc of Arts—July 24, 1903. Serial. 1st part. No. 57207 A.

Phenomena of the Antennæ in Wireless Telegraphy (Sur les Phénoménes de l'Antenne de la Télégraphie sans Fils). MM. Broca and Turchini. A description of investigations made, with a form of electrodynamometer especially devised for the study of the action of the currents in the antennæ. 1200 w. Comptes Rendus—June 29, 1903. No. 57340 D.

The Fessenden System of Spark Telegraphy (Die Funkentelegraphie nach Fessenden). H. Lindow. An abstract of the Fessenden wireless telegraphy patents. 6000 w. Elektrotech Zeitschr—July 23, 1903. No. 57347 B.

The Lodge-Muirhead System of Wireless Telegraphy. A. Frederick Collins. An account of the development of this system, with illustrated description of its novel features. 3000 w. Elec Wld & Engr—Aug. 1, 1903. No. 57090.

Telephony.

Is State Ownership of Telephones Desirable? F. Dagger. Information regarding the results of government ownership in Austria, Belgium, France, Germany, Switzerland, and Luxemburg, showing the service generally unsatisfactory. 1600 w. Can Engr—Aug., 1903. No. 57134.

Properties of Wire Used in Telephone Work. R. A. L. Snyder. Considers the seven kinds of wire used, and their different properties, and the uses of each. 1000 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57464 D.

The New Denver Telephone Exchange of the Colorado Telephone Company. C. W. Whitney. An illustrated detailed description of the building and its equipment. 4800 w. Elec Wld & Engr—Aug. 22, 1903. No. 57536.

DISTRIBUTION.

Cables.

The Heating of Buried Cables (Ueber die Erwärmung im Erdboden Verlegter Starkstromkabel). Paul Humann. Data and results of experiments made by Felten and Guillaume upon the heating of buried cables subjected to the passage of heavy currents. 3000 w. Elektrotech Zeitschr—July 30, 1903. No. 57348 B.

Conductors.

Methods of Bringing High Tension Conductors into Buildings. C. E. Skinner. Discusses the general requirements, referring to specific methods. Ill. 1200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57418 D.

Conduits.

Electric Conduit Construction at Cincinnati, O. Illustrated description of a very extensive underground conduit system for the purpose of supplying current to the street arc lamps. 2500 w. Eng News—Aug. 20, 1903. No. 57541.

Converters.

American Converters (Ueber Amerikanische Umformer). A. Hruschka. A review of American practice in the use of converters and transformers in electric tramway service. 3500 w. Elektrotech Zeitschr—July 23, 1903. No. 57344 B.

Energy Transformations in the Synchronous Converter. William S. Franklin. The object of the paper is to determine the fractional part of the total energy which is conductively transferred from supply mains to service mains and the part which is inductively transferred. 3500 w. Trans Am Inst Elec Engrs—July, 1903. No. 57404 D.

Storage Batteries.

The Storage Battery in Sub-stations. W. E. Goldsborough and P. E. Fansler. An account of tests made on a large interurban system to determine the storage battery equipment needed and showing the character of the demands which the battery has to meet. Ill. 7800 w. Trans Am Inst of Elec Engrs—July, 1903. No 57410 D.

Sub-Stations.

The Sub-Stations of the Elevated Railways in New York (Die Unter-Stationen der New Yorker Hochbahn). S. S. G. Freund. Illustrated description of the transforming sub-stations in New York, in which the current from the main station at 77th street is reduced and converted for delivery to the third rail. 2500 w. Elektrotech Zeitschr—Aug. 6, 1903. No. 57351 B.

Switches.

Automatic Release for High-Tension Switches (Ueber die Auslösung von Automatischen Hochspannungsschaltern). Max Vogelsang. Illustrating a special form of automatic switch for action by continuous current. 1800 w. Elektrotech Zeitschr—July 30, 1903. No. 57349 B.

High Pressure Oil Switches (Hochspannungs-Oelschalter). Dr. G. Benischke. A discussion of the advantages of oil insulation for switches for high-pressure currents, with examples of construction. 2500 w. Elektrotech Zeitschr—July 30, 1903. No. 57350 B.

Transformers.

Effect of Series Resistance in the Primary Circuit of a Transformer. H. A Pikler. Shows that by sending a sine

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wave exciting current through the transformer we get the e. m. f. wave distorted. 1200 w. Elec Wld & Engr—Aug. 8, 1903. No. 57157.

High Tension Transformers. J. W. Farley. Describes the transformers as typical of the latest and best engineering practice in the design of high tension apparatus. 3700 w. Cent Sta—Aug., 1903. No. 57166.

Leblanc Rectifying Transformer. Explains the fundamental principle of this invention. 2000 w. Elec Wld & Engr—Aug. 22, 1903. No. 57539.

Y or Δ Connection of Transformers. F. O. Blackwell. Also discussion by J. S. Peck. A general statement of the advantages and disadvantages of both connections, as they appear to the writer. Mr. Peck discusses the question of grounding or not grounding the neutral and the best method of connecting transformers. 4300 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57419 D.

Wiring.

Alternating Current Wiring. Cecil P. Poole. Tables, formulæ and directions for making the necessary calculations 2000 w. Am Elect'n—Aug., 1903. No. 57088.

Electric Wiring and Fire Risks. E. C. de Segundo. Read before the International Fire Prevention Cong. On the importance of sound work in the wiring of buildings for electric light and power. 3000 w. Archt, Lond—Aug. 14, 1903. No. 57471 A.

ELECTRO-CHEMISTRY.

Accumulator.

The Jungner-Edison Accumulator (Der Jungner-Edisonsche Akkumulator). M. U. Schoop. A comparison of the lead and the alkali accumulators, with data of tests, and a summing up of the advantages and defects of the respective types. 4500 w. Elektrotech Zeitschr—Aug. 6, 1903. No. 57352 B.

Alkali Earths.

The Electrolysis of Sulphides of the Alkali Earths (Ueber die Elektrolyse der Erdalkalisulfide). André Brochet and Georges Ranson. An account of experimental researches, principally with barium sulphide. 1500 w. Zeitschr f Elektrochemie—June 25, 1903. No. 56957 G.

Cerium.

The Electromotive Force of Cerium Oxide (Ueber das Elektromotorische Verhalten der Oxyde des Cers). E. Baur and A. Glaessner. An experimental investigation of the oxidation and reduction electric potentials of solutions of cerium salts. 2000 w. Zeitschr f Elektrochemie—June 25, 1903. No. 56958 G.

Discoveries.

Electrochemical Discoveries. Reviews the industries that have grown up around Niagara, and the experimental companies formed for the purpose of discovering new processes. 1500 w. Sci Am—Aug. 1, 1903. No. 57049.

Electrodeposition.

Electrodeposition on Rotating Cathodes. J. G. Zimmerman. Gives data and observations obtained from an investigation of such means recently carried on at the Univ. of Wisconsin. 2000 w. Wis Engr—June, 1903. No. 57442 D.

Electro-Metallurgy.

The Development of Electro-Metallurgy (Ueber die Fortschritte der Elektrometallurgie). Dr. Heinrich Paweck. Paper before the Oesterr. Ing.- und Architektenverein, giving a general review, with bibliography. 2 Parts. 4000 w. Oesterr Zeitsch f Berg u Hüttenwesen—June 13 and 20, 1903. No. 56948 each D.

Ferrosilicon.

Ferrosilicon in France. Information concerning ferrosilicon manufactured by the electrical process, and a statement of the advantages of high-grade ferrosilicon. 1800 w. U S Cons Repts, No. 1713—Aug. 3, 1903. No. 56876 D.

Lead Salts.

The Anode Potential During the Formation of Lead Carbonate and Lead Chromate (Ueber Anodenpotentiale bei Bildung von Bleikarbonat und Bleichromat). G. Just. Electrolytic experiments with lead electrodes. Tables. 1000 w. Zeitschr f Elektrochemie—July 2, 1903. No. 56959 G.

Separation.

Notes on the Quantitative Electrolytic Separation of Metals (Beiträge zur Kenntnis der Quantitativen Elektrolytischen Metallabscheidung). P. Denso. A description of laboratory methods of analysis, with illustration, diagrams and tables. 3500 w. Zeitschr f Elektrochemie—June 4, 1903. No. 56951 G.

Steel Making.

Manufacture of Steel by the Electric Furnace. Translation published in *Iron Age*, with additions by P. McN. Bennie of a paper by Charles Bertolus, of St. Etienne, France, entitled "Notice sur la Fabrication des Aciers au Four Electrique." 4800 w. Sci Am Sup—Aug. 1, 1903. No. 57054.

Thallium Accumulator.

The Thallium Accumulator (Ueber den Thallium-Akkumulator). L. Jonas. Theoretical and experimental investigations. 3000 w. Zeitschr f Elektrochemie—June 25, 1903. No. 56956 G.

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ELECTRO-PHYSICS.

Electrostatics.

To Whom Do We Owe the Experiment of the Ball and Hemispherical Conductors, Showing That the Charge Resides on the Outer Surface of an Electrified Body? Brother Potamion. Shows that the experiment was first performed by Cavindish, in 1773, and that the benefit to the world came through the work of Coulomb, 1788. 1700 w. Elec Wld & Engr—Aug. 22, 1903. No. 57537.

Magnetic Observatories.

The Magnetic Observatories of the United States Coast and Geodetic Survey in Operation on July 1, 1902. L. A. Bauer and J. A. Fleming. From the annual report of the Supt. of the U. S. Coast & Geodetic Survey, 1902. Illustrated descriptions. 3300 w. Sci Am Sup—Aug. 8, 1903. No. 57174.

Precision.

The Necessity for Precision of Statement in Technical Work. H. M. Hobart. Especially considers the subject in its bearing on electrical work, illustrating by important questions which have been only superficially discussed. 1600 w. Elec Rev, Lond—Aug. 7, 1903. Serial. 1st part No. 57227 A.

Radioactivity.

Experiments in Radioactivity, and the Production of Helium from Radium. Sir William Ramsay and Mr. Frederic Soddy. Report of experimental investigations. 1500 w. Nature—Aug. 13, 1903. No. 57468 A.

On the Intensely Penetrating Rays of Radium. Hon. R. J. Strutt. A report of results of investigations made. 600 w. Nature—Aug. 13, 1903. No. 57469 A.

Radioactivity of Thorium Minerals. George F. Barker. A review of recent investigations and the conclusions reached. 2800 w. Am Jour of Sci—Aug., 1903. No. 57434 D.

To Manufacture Radium. An account of a company formed to extract the rare metal radium from uranium ores obtained from Utah beds. 800 w. Ir Age—Aug. 27, 1903. No. 57561.

Resonance.

On Resonance Coils. T. Mizuno. Shows the advantages of the coil system in investigating electric waves, and describes methods of investigation. Ill. 1500 w. Elect'n, Lond—Aug. 7, 1903. Serial. 1st part. No. 57228 A.

Static Discharge.

Eccentricities of the Static Discharge. Walton Harrison. Illustrates and describes an experiment of Hertz, and modifications by other investigators. 700 w. Sci Am—Aug. 8, 1903. No. 57167.

GENERATING STATIONS.

Alternating Current.

The Management of Alternating Current Machinery. George T. Hanchett. Suggestions for successful operation. Ill. 2000 w. Cent Sta—Aug., 1903. No. 57165.

Alternators.

Commercial Alternator Design. W. L. Waters. An illustrated discussion of various designs and of the chief factors in deciding the design of a machine. 4300 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57405 D.

Apprentices.

Notes on What and How to Learn in an Electrical Engineering Works. G. Ralph. Calls attention to things an apprentice should look out for in the various departments. 2200 w. Elec Engr, Lond—Aug. 7, 1903. No. 57224 A.

Belfort.

Electric Works at Belfort. Illustrated detailed description of these model shops. 1000 w. Engr, Lond—July 31, 1903. No. 57129 A.

Brussels.

Electrical Installation of the City of Brussels, Belgium. Enrico Bignami. An illustrated article describing the character of the work necessary to keep up with the growth of the city and demand for increased service. 2800 w. Elec Rev, N. Y.—Aug. 15, 1903. No. 57258.

Coil Forming.

See Mechanical Engineering, Machine Works.

Combined Plant.

A Combined Railway, Lighting and Ice Plant at Hampton, Va. An illustrated detailed description of a noteworthy example of a combined plant. 4000 w. St Ry Jour—Aug. 15, 1903. No. 57253 D.

Costs.

Economy of Fuel in Electric Generating Stations. Henry McLaren. Remarks based on table of costs published by *The Electrical Times*, London, with suggestions for better economy. 4500 w. Inst Mech Engr—July, 1903. No. 57121 D.

Demand.

Some Observations on Electricity Supply and Methods of Stimulating Demand. J. E. Panton. Brief review of the development of electric supply undertakings in England, with discussion of important features. Considers reliability of service and cost as of first importance, and suggests means of increasing the supply. 4800 w. Elec Engr, Lond—July 31, 1903. No. 57116 A.

Diesel Motor.

See Mechanical Engng., Special Motors.

Disconnecting.

The Use of Automatic Means for Disconnecting Disabled Apparatus. H. G. Stott. Discusses generating apparatus, transmission apparatus, and receiving apparatus, giving suggestions for safety. 1200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57424 D.

Dresden.

The Electrical and Heating Station in Dresden (Das Fernheiz und Elektrizitätswerk in Dresden). General description of steam power plant and electric generating sation, including long-distance distribution of steam for heating purposes. 2,000 w. Schweizerische Bauzeitung—July 18, 1903. No. 57329 B.

Economies.

Central Station Economies. W. E Goldsborough and P. E. Fansler. An account of a comprehensive test made to determine the economies of the main power station of the Union Traction Co., of Indiana. Ill. 7800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57408 D.

Failures.

Electrical Plant Failures, Their Origin and Prevention. A. Campbell Cormack. Statistics of accidents showing their nature, the origin, and giving an analysis of the causes. 3000 w. Elect'n, Lond—Aug 14, 1903. No. 57487 A.

Generators.

Care and Management of Electric Generators. Edwin W. Creed. Suggestions from practical experience, useful to men having the care of this kind of machinery. Ill. 2500 w. Power—Aug., 1903. No. 56866 C.

"Hunting."

The "Hunting" of Alternating-Current Machines. Bertram Hopkinson. Communication to the Royal Society. An investigation of causes and a study of the general effect upon stability of running. 6000 w. Elect'n, Lond—Aug. 7 and 14, 1903. Serial. 2 parts. No. 57229 each A.

Hydro-Electric Plants.

A Mexican Water-Power Electric Plant. Illustrated description of a small but interesting plant at San Simonito, supplying current for lighting and power to Toluca, and other towns and villages within twenty miles. 2000 w. Eng News—Aug. 13, 1903. No. 57277.

Electric Power from Mount Rainier. Brief illustrated description of a plant utilizing the glaciers of Mount Rainier as a source of water supply. 1000 w. Rev of Revs—Aug., 1903. No. 57206 C.

Hydraulic-Electric Development of the Neversink Light and Power Company, Middletown, N. Y. Illustrated description of an interesting development which utilizes the abandoned works and canal of the Delaware & Hudson Canal Co. 1700 w. Elec Wld & Engr—Aug. 8, 1903. No. 57156.

Hydro-Electric Power Stations in Italy. This article describes and illustrates the power station of Vizzola, on the river Ticino. Brief reference is made to other interesting stations. 1800 w. Elec Rev, Lond—July 24, 1903. No. 57019 A.

Power-Development in Southern California. L. R. Freeman. Remarks on the value of water in California, especially in the arid regions, with an account of the great power development and transmission plants, with brief description of the Edison Co. Mill Creek Plant, No. 3. Ill. 1700 w. Rev of Revs—Aug., 1903. No. 57205 C.

The Cauvery Falls Hydro-Electric Plant (Usine Hydro-Electrique de Cauvery Falls). F. Drouin. An illustrated description of the plant at Sivasamudram, in southern India; 7,500 h. p. are taken from the falls of the Cauvery river. 2500 w. 1 plate. Génie Civil—July 25, 1903. No. 57310 D.

The Electric Generating Station at Gersthofen on Lech (Das Elektrizitätswerk Gersthofen am Lech). Kurt Meyer. An illustrated description of the plant at Gersthofen near Augsburg, Bavaria, where 6,000 H. P. is taken from the Lech, and delivered to Augsburg and the vicinity for lighting and electro chemical industries. Serial. Part 1. 3000 w. Zeitscher d Ver Deutscher Ing—July 18, 1903. No. 57,301 D.

The great Electric Installations of Italy. E. Bignami. A fully illustrated description of the power plant at Tivoli and the transmission of electrical energy to Rome. 3000 w. Enginering Magazine—Sept., 1093. No. 57362 B.

The Harnessed Hudson. Thomas Commerford Martin. Reviews the rapid development of water power in the United States, especially considering the recent work at Spiers Falls. Ill. 1400 w. Rev of Revs—Aug., 1903. No. 57204 C.

Insulation.

Defective Machine Insulation. C. E. Farrington. On the defective insulation which is found in modern dynamo and motor construction, outlining investigations made to determine a good insulating compound. 3800 w. Jour Fr Inst—Aug., 1903. No. 57438 D.

Niagara.

Canadian Electrical Development at Niagara. A brief account of the extensive work being carried out, with map. 600 w. Engr, Lond—Aug. 7, 1903. No. 57238 A.

Power Companies.

The Sphere of Utility of a Power Com-

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pany. Alderman G. Pearson. Read before the Munich Elec. Assn. at Newcastle-on-Tyne. Discusses the question as related to England particularly, with aim of finding some common ground of agreement between power companies and municipalities, whereby they may be able to avoid competition. 3300 w. Elec Engr, London—July 24, 1903. No. 57017 A.

Power Plants.

See Mechanical Engineering, Steam Engineering.

Storage Batteries.

The Storage Battery in Its Relation to U. S. Fortifications. Lee Hagood. Facts about the storage battery, with special reference to its applications and use in seacoast fortifications. Considers the technical features, care and management of these batteries. 7000 w. Ill. Jour U. S. Art—July-Aug., 1903. Serial. 1st part. No. 57549 D.

Tramway Stations.

A 57,000 Kilowatt Steam Turbine Station. Brief illustrated description of the principal features of the generating station under construction at Chelsea, Eng., by the Underground Elec. Ry. Co., of London, Ltd. 1000 w. Power—Aug., 1903. No. 56867 C.

New High Tension Alternating Current Installation of the Berkshire Street Railway Company at Pittsfield, Mass. W. G. Viall. Illustrated detailed description. 3000 w. Am Elect'n—Aug., 1903. No. 57084.

The Missouri River Power Station of the Metropolitan Street Railway Company of Kansas City, Mo. Illustrated detailed description of one of the largest power stations in the United States. Curtis steam turbines are to be installed. 4000 w. St Ry Jour—Aug. 1, 1903. No. 57081 D.

Wimbledon.

Wimbledon Electricity Works. Illustrated descrintion of a combined refuse destructor and electricity works for a residential suburb of London. The town has a very remarkable development of street lighting by electricity which is entirely controlled from the generating station. 2800 w. Elec Rev, Lond—Aug. 14, 1903. No. 57482 A.

LIGHTING.

Car Lighting.

An Electric Car Lighting System. W. L. Bliss. An illustrated description of an axle-driven electric car lighting system in which the generator is located on the truck frame, the armature being rotated by means of a single reduction gearing. 6800 w. Pro St Louis Ry Club—July 10, 1903. No. 57429.

Train Lighting with Steam Turbines. Geheimrath Weichert. Abstract translation from a report on the Prussian Nat. Rys. presented at the German Engrs. convention. Illustrated detailed description of the system adopted, with brief review of other systems. 4000 w. Sci Am Sup—Aug. 1, 1903. No. 57053.

Economies.

The Possibilities of Future Economies in Electrical Illumination. W. A. Chamen. Read before the Incor. Munic. Elec. Assn. Discusses incandescent lamps, the Howitt mercury vapor lamp, arc lamps, and the possible improvements. Short discussion. 4500 w. Elect'n, Lond—July 24, 1903. No. 57020 A.

Hot Wire.

Hot Wire Enclosed Arc Lamps. H. Tomlinson-Lee. An illustrated article describing the "hot-wire" lamp invented by C. E. Foster, with reports of its advantages. 1200 w. Elec Rev, Lond—July 31, 1903. No. 57118 A.

Lighthouse.

Modern Searchlights. Frank C. Perkins. Illustrates and describes the new form of electric flashlight installed in the lighthouse tower at Heligoland. 600 w. Sci Am—Aug. 22, 1903. No. 57293.

Torpedo Boats.

Electric Light Plant for Dutch Torpedo Boats. Illustrations and brief description of plant for working the search lights, and for general lighting purposes. 350 w. Engng—July 31, 1903. No. 57127 A.

MEASUREMENT.

Alternating Currents.

Power Measurement on Alternating-Current Circuits. R. B. Williamson. Considers points affecting the determination of power and methods of making power measurements. 2000 w. Elec Rev N. Y.—Aug. 15, 1903. Serial. 1st part. No. 57257.

Cable Testing.

Tests on Broken Cables—Some Inconsistencies in Localization Formulae. E. Raymond-Barker. Calls attention to various inconsistencies in text-book formulae, and summarizes the several formulae which have appeared. 1100 w. Elec Rev, Lond—Aug. 14, 1903. Serial. 1st part. No. 57480 A.

Meters.

The Influence of the Curve Form upon Induction Meters (Uber den Einfluss der Kurvenform auf Induktionszähler). Dr. G. Stern. An examination of alternating meters of the Ferraris type, showing that the form of the alternating-current curve affects the readings. 3000 w. Elektrotech Zeitschr—July 23, 1903. No. 57345 B.

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Motor Diagrams.

The Polar Diagram of the Compensated Motor (Das Kreisdiagramm des Kompensierten Motors). A. Heyland. An examination of the effect of compensation upon the induction motor, using the vector diagram, showing the degree of compensation and position of brushes giving maximum efficiency. 2500 w. Elektrotech Zeitschr—July 23, 1903. No. 57346 B.

Selector.

The Detection of the Finishing Temperature of Steel Rails by the Thermo-Magnetic Selector. Albert Sauveur and Jasper Whiting. Describes a method of testing to prevent the rolling of coarsely crystalline rails, illustrating the most promising devices yet conceived for meeting the requirements. 1400 w. R R Gaz —Aug. 14, 1903. No. 57270.

Self Induction.

A Method of Determining the Coefficient of Self Induction (Methode zur Vergleichung von Selbstinduktionskoefficienten und Kondensatoren). Dr. G. Brion. Describing the method using the wheatstone bridge, with a telephone instead of a galvanometer. 1200 w. Elektrotech Zeitschr—Aug. 6, 1903. No. 57353 B

Testing.

The Testing of Electrical Apparatus for Dielectric Strength. P. H. Thomas. A brief dissension of objections to the present method of over potential tests, especially in regard to insulation tests upon very high tension apparatus. 3000 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57417 D.

Wattmeters.

Some Tests of Recording Wattmeters. Ingwald A. Rosok. An account of tests made of several makes. 1200 w. Elec Wld & Engr—Aug. 22, 1903. No. 57538.

POWER APPLICATIONS.

Agriculture.

The Use of Electric Power in Plowing. Emile Guarini. Illustrated description of some new applications of electricity to the cultivating of farms. 2400 w. Elec Rev, N. Y.—Aug. 8, 1903. No. 57148.

Battleship Installation.

The Electric Installation on Board U. S. Battleships Connecticut and Louisiana. R. M. Klein. Illustrated detailed description of the electric applications aboard these ships and the plants for handling the entire load. 7000 w. Elec Wld & Engr—Aug. 15, 1903. No. 57265.

Coal Hoist.

An Electrically-Operated Coal Hoist. Richard Lamb. Illustrates and describes a plant that does not use varying voltage generators. 1500 w. Elec Wld & Engr —Aug. 1, 1903. No. 57093.

Cranes.

Electric Harbor Cranes (Ueber Elektrische Hafenkräne). J. Rothmüller. Illustrating and describing various forms of cranes for use on docks, quays and other harbor service, showing the extent to which electricity has replaced hydraulic power. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 17, 1903. No. 57327 D.

Dredge.

Electrically-Driven Ladder Dredge. Illustrated description of a ladder dredge in use on the river Esla, in Spain, which is electrically driven throughout. 800 w. Marine Engng—Aug., 1903. No. 56895 C.

The Electrical Equipment of a Gold Dredge. Ralph L. Montague. Explains the use and object of these dredges and describes the electrical equipment. Ill. 3800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57407 D.

Electric Locomotives.

See Street and Electric Railways.

Electric Traction.

See Street and Electric Railways.

Induction Motor.

Design for a One Horse-Power Self Starting Single-Phase Induction Motor. Drawings and description of the essential features of a motor capable of giving one brake horse-power on a single-phase circuit of 100 volts and 125 to 133 cycles. 1800 w. Am Elect'n—Aug., 1903. No. 57087.

Mine Hoists.

The Electrical Driving of Winding Gears. F. Hird. Abstract of paper read before the Inst. of Min. Engrs. Describes the controlling apparatus used by different designers, and other features of interest. 3800 w. Elect'n, Lond—Aug. 14, 1903. No. 57485 A.

Mining.

Electrical Day at the Institution of Mining Engineers, London. Sidney F. Walker. A review of the electrical papers presented, and the discussions. 2000 w. Elec Rev, N. Y.—Aug. 1, 1903. No. 56896.

Electric Power Appliances in the Mines of Europe. Emile Guarini. M. Guarini's second paper deals with the direct applications of electric power to ore getting, hauling, and hoisting. 3500 w. Engineering Magazine—Sept., 1903. No. 57365 B.

Motor Diagrams.

See Electrical Engineering, Measurement.

Paper Mill.

The Electrical Plant of the Albbruck Paper Works in the Southern Black Forest (Elektrizitätswerk der Papierfabrik

Albbruck im Südlichen Schwarzwald). F. Allemann Gisi. A will illustrated detailed description of a hydro-electric plant in Baden, near the Rhine. 4 parts. 7000 w. Schweiz Bauzeitung—July 4, 11, Aug. 1 and 8, 1903. No. 56953 each D.

Speed Control.

Notes on the Speed Regulations of Continuous-Current Motors. Wallace Rogers. Considers the effect of weakening the field as a means of speed regulation, and its disadvantages. Also considers other methods both as regards stationary and traction work. 2200 w. Elec Engr, Lond —Aug. 14, 1903. No. 57478 A.

Woodworking.

Woodworking Machinery. Gives illustrated descriptions of various machines showing important developments in individual driving by electric motors. 1200 w. Am Engr & R R Jour—Aug., 1903. No. 56873 C.

TRANSMISSION.

Aluminum.

Aluminum Conductors of Electric Transmission Lines. Alton D. Adams. A comparison of the questions of the conductivity, cost and maintenance of aluminum lines and those of copper. 3000 w. Engineering Magazine—Sept., 1903. No. 57366 B.

Converters.

See Electrical Engineering, Distribution.

France.

The Recently Installed Saut-Mortier Electrical Power Transmission Plant in France. Frank C. Perkins. Illustrated description. 1500 w. Elec Rev, N. Y.—Aug. 22, 1903. No. 57526.

Frequencies.

Choice of Frequency for Very Long Lines. P. M. Lincoln. Discusses which is the better frequency for a very long line, 60 or 25 cycles per second, considered purely as a transmission problem. 1200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57420 D.

High Voltage.

Electric Cables for High Voltage Service. Henry W. Fischer. Discusses the manufacture of paper-insulated and rubber-insulated cables, their installation, and operation. 1200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57423 D.

High Tension Cables and Overhead Transmission. Charles C. Gerrard. A brief comparison of overhead and underground transmission with special reference to English conditions. 1500 w. Elec Rev, Lond—Aug. 14, 1903. No. 57479 A.

The Operation and Maintenance of High Tension Underground Systems. Philip Torchio. Notes applying mainly to moderately high-tension systems as installed in large cities in the last few years. Ill. 900 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57422 D.

Lightning.

The Grounded Wire as a Protection Against Lightning. Ralph D. Mershon. Discusses the efficacy of wires strung parallel to the power wires and grounded at intervals for the protection of transmission lines. 1800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57421 D.

Switching.

Switching Transmission Circuits. Alton D. Adams. Outlines facts that have led to the development of oil switches, describing these switches and their operation. 4000 w. Elec Rev, N. Y.—Aug. 22, 1903. No. 57525.

Transformers.

See Electrical Engineering, Distribution.

MISCELLANY.

Shocks.

The Danger of Shock to Firemen Through Squirting High-Tension Mains. Abstract of an article by F. Heinicke in the *Elektrotechnische Zeitschrift*. An account of experiments carried out, with the conclusion that the danger from this source is not so great as supposed. 800 w. Elec Engr, Lond—Aug. 7, 1903. No. 57225 A.

GAS WORKS ENGINEERING

Acetylene.

Development in Acetylene. J. H. Chewett. Read before the Engrs. Club of Toronto. Reviews the history of the development and discusses the advantages and value of the gas. 2800 w. Can Engr —Aug., 1903. No. 57133.

Impurities and Purification of Acetylene. G. Kappeler, in the *Jour. of Gasbeleucht.* A resume of the impurities which have been discovered in acetylene, and the methods devised to improve them. 2000 w. Sci Am Sup—Aug. 8, 1903. No. 57175.

The Principal Properties of Acetylene Solutions (L' Acetylene Dissons et ses Principales Applications). A. Janet. A description of the success which has been

We supply copies of these articles. See page 157.

attended in the practical use of acetylene dissolved in acetone, especially for illuminating purposes and for the oxy-acetylene blowpipe. 2000 w. Génie Civil—July 18, 1903. No. 57309 D.

Benzine.

Determination of Benzine in Gas. L. M. Dennis and J. G. O'Neill. From the *Jour. Am. Chem. Soc.* An account of experimental investigations showing that alcohol does not completely remove either benzine or athylene, and that an ammoniacal solution of nickel nitrate furnishes a rapid and exact method for the determination. 3000 w. Jour Gas Lgt—Aug. 11, 1903. No. 57291 A.

Carbonizing.

The Settle-Padfield Carbonizing Process. Norton H. Humphreys. Notes and results of tests of interest. 900 w. Jour Gas Lgt—July 28, 1903. No. 57108 A.

The Way of Improvement in Coal Carbonization. Comment on the new systems of carbonization and new proposals for improvements of methods and appliances. 2300 w. Jour Gas Lgt—July 21, 1903. No. 56878 A.

Chandeliers.

Improvement of the Chandelier for Gas and Electric Lighting. A Hallard. An illustrated article describing the "Surprise pendant," a chandelier especially designed by an English firm for the incandescent burner, which can be used at any height. 1500 w. Archt Rec—Aug., 1903. No. 56860 C.

Coal Gas.

Remarks Upon the Principles Involved in the Production of Gases from Coal, and Suggestions as to their Application in Future Developments. William Young. Read at meeting of the N. British Assn. of Gas Mgrs. Also general discussion. 9000 w. Gas Wld—Aug. 1, 1903. No. 57111 A.

Coal Handling.

Coal and Coke Handling Plant at Dunfermline Gas Works. A Waddell. Read before the N. British Assn. of Gas Mgrs. Illustrates and describes a combination coal and coke plant, stating its capabilities Discussion. 3200 w. Gas Wld—Aug. 15, 1903. No. 57477 A.

Gas Coals.

The Valuation of Gas Coals. A paper read before the N. of England Inst. of Min. & Mech. Engrs., with the chief portions of the discussion. 2500 w. Gas Wld—July 25, 1903. No. 57014 A.

High Pressure.

High Pressure Gas Distribution. John A. Britton. Read before the Pacific Coast Gas Assn. Shows how high pressure gas may be utilized. 4000 w. Am Gas Lgt Jour—Aug. 17, 1903. No. 57249.

Incandescence.

Incandescent Lighting in Western Australia. W. G. Quicke. A report of the degree of success in the introduction of the Welsbach incandescent system, the difficulty in securing really good mantles, &c. 1000 w. Jour Gas Lgt—July 21, 1903. No. 56880 A.

Loss of Illuminating Power of Mantles while Burning. Alfred H. White and M. E. Mueller. Prepared for meeting of the Michigan Gas Assn. A study of the causes of deterioration of mantles while burning. 5000 w. Am Gas Lgt Jour—Aug. 3, 1903. No. 57058.

Liquid Air.

Liquid Air: Its Manufacture, Distillation into Commercial Oxygen and Nitrogen, and the Application of Oxygen in the Industries, Especially for Use in Connection with Illuminating Gas. G. A. Bobrick. Read before the Pacific Coast Gas Assn. Reviews the history of the liquefaction of gas and describes the processes, now employed in the manufacture of liquid air and its distillation. 4800 w. Am Gas Lgt Jour—Aug. 24, 1903. No. 57516.

Metal Protection.

The Practical Protection of Metal Surfaces in Gas Plants. L. P. Lowe. Read before the Pacific Coast Gas Assn. Considers the preservation of corrosive metal surfaces about gas plants, including buildings, machinery, gasholders, tanks, mains, pipes, &c. 5000 w. Am Gas Lgt Jour—Aug. 24, 1903. No. 57517.

Meters.

Prepayment Gas Apparatus. Dr. H. Aron. Abstract translation of a paper before the German Assn. of Gas & Water Engrs. Shows how important a factor these meters have become and discusses features of the mechanism. 1400 w. Jour Gas Lgt—July 28, 1903. N. 57109 A.

Mixer.

A Proportional Gas Mixer (Doseur-Mélangeur de Gaz). A. Binet. A form of duplex gas meter, so arranged that air and gas, or gas and acetylene may be mixed in pre-determined proportions. 1000 w. Génie Civil—July 25, 1903. No. 57312 D.

Monazite.

A Visit to the Monazite Sand Deposits of Brazil. Joseph Tysoe. An account of a recent visit to Brazil in the interests of the gas industry. 2300 w. Jour Gas Lgt—July 28, 1903. No. 57107 A.

The Fight for the Gas Industry for a Controlling Hand Over Monazite. On the importance of the monazite sand and thorium question to the gas industry, and Mr. J. Tysoe's mission to Brazil. 3000 w. Jour Gas Lgt—July 21, 1903. No. 56877 A.

We supply copies of these articles. See page 157.

Natural Gas.

Natural Gas in England. Inverness Watts. An account of the discovery and development. Ill. 1400 w. Cassier's Mag—Aug., 1903. No. 57283 B.

Oil Gas.

Manufacture and Employment of Gas from Heavy Oil in Germany. M. W. Scheihauer. From the *Jour. für Gasbeleuchtung*. Describes the gas-producing apparatus and the manufacture of the gas. 3400 w. Sci Am Sup—Aug. 15, 1903. No. 57197.

Pipes.

Wrought Pipe. Franklin Riffle. Read at meeting of Pacific Coast Gas Assn. Reviews the history and development of the pipe industry, giving tests made, and comparison of steel pipe and wrought iron pipe, etc. 8000 w. Am Gas Lgt Jour—Aug. 17, 1903. No. 57250.

"Producer" Gas.

Should Gas Companies and Corporations Vend "Producer" Gas? Discusses British legislation favorable to a Mond gas supply and the effect on the gas interests. 2300 w. Jour Gas Lgt—Aug. 11, 1903. Serial. 1st part. No. 57289 A.

Purification.

Quadrupling the Capacity of an Ordinary Purifier House at Very Small Cost. F. H. Shelton. Read before the Western Gas Assn. Suggests a simple and effective method of increasing the capacity at small expense. Ill. General discussion. 4000 w. Pro Age—Aug. 1, 1903. No. 57056.

The Purification of Gas from Sulphur. H. Leicester Greville. Discusses the purification from sulphur compounds other than sulphuretted hydrogen. 2400 w Jour Gas Lgt—Aug. 4, 1903. No. 57215 A.

Retorts.

Heat Conductivity of Gas Retorts. H. A. Wheeler. Read before the Western Gas Assn. Describes methods of testing to determine if different makes of gas retorts have different rates of transmitting heat, discussing results. General discussion. 3400 w. Pro Age—Aug. 1, 1903 No. 57055.

Settings.

I. Gaseous Firing at Waterford Gasworks. R. Bruce Anderson. II. The Progress of Regenerative Settings since 1880. William Dunn. Two papers read before the Irish Assn. of Gas Mgrs. and discussed together. The first gives an illustrated description of the settings. The second paper deals with regenerative furnaces as applied to heating gas retorts, showing that there has been practically no improvement in construction or results for the past twenty-three years. Ill. 11300 w. Gas Wld—Aug. 15, 1903. No. 57476 A.

Stoking Machinery.

A German Installation of West's Retort-Stoking Machinery. Illustrates and describes the reconstruction of the Crefeld gas-works, and the successful working of this machinery, as given in an address by Herr Salzenberg. 4500 w. Jour Gas Lgt—July 28, 1903. No. 57106 A.

Sulphate of Ammonia.

The Manufacture of Sulphate of Ammonia. George Keillor. Read before the N. Brtish Assn. of Gas Mgrs. Discusses whether it is profitable to manufacture sulphate of ammonia in small gas-works, deciding in the affirmative and giving suggestions. 8500 w. Gas Wld—Aug. 1, 1903. No. 57112 A.

Water Gas.

Water Gas Manufacture by the Kramers and Aarts Process. Abstract of a paper by Dr. Alph. Steger at a recent meeting of the German and Swiss Assns. of Gas & Water Engrs. Considers both the continuous and intermittent methods of producing simple water gas. 4200 w. Jour Gas Lgt—July 21, 1903. No. 56882 A.

Widnes.

Widnes Gas and Water Works. Isaac Carr. Read at a Dist. meeting of the Assn. of Munic. & Co. Engrs. Describes these two undertakings and reports results obtained. 3800 w. Jour Gas Lgt—July 28, 1903. No. 57110 A.

Winterthur.

The Enlargement of the City Gas Works of Winterthur, Switzerland (Die Erweiterung des Städtischen Gaswerkes Winterthur). A general illustrated description. 3000 w. Schweiz Bauzeitung —June 13, 1903. No. 56951 D.

Works.

The Gas Works at Mariendorf near Berlin (Die Gasanstalt in Mariendorf bei Berlin). E. Körting. General description of plant, including inclined retorts, coal and coke handling machinery, and gasholders. The capacity is 800,000 tons of coal per year. 4000 w. Zeitschr d Ver Deutscher Ing—July 25, 1903. No. 57304 D.

The New Gas-Works at Haarlem. An illustrated description based on the presidential address of J. Blom, before the Dutch Assn. of Gas Mgrs., and on a recent inspection of the works. 1500 w. Jour Gas Lgt—July 21, 1903. No. 56879 A.

Widnes Gas-Works. Isaac Carr. A detailed description by the engineer. 1600 w. Gas Wld—July 25, 1903. No. 57015 A.

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INDUSTRIAL ECONOMY

Apprentices.

See Electrical Engineering, Generating Stations.

British Tariff.

British Iron and Steel and the Proposed Fiscal Tariff. States the arguments of those who believe that a preferential tariff is of first importance to the welfare of these industries. 2800 w. Ir Age—Aug. 20, 1903. No. 57286.

British Trade.

Free Trade and Protection from the Workman's Point of View. M. Maltman Barrie. A discussion of the value of Mr. Chamberlain's proposals to the British workman. 7200 w. Nineteenth Cent—Aug., 1903. No. 57248 D.

Coal Industry.

The Cheapening of Coal. F. E. Saward. Discusses features of the coal industry, the surplus of pea, buck, and rice sizes, and the effect on prices. Also the tendency of bituminous sizes. 1500 w. Ir Age—Aug. 20, 1903. No. 57285.

Education.

A Century's Progress in Engineering Education in the United States. Robert Heywood Fernald. Reviews the development of technical education from the earliest times. 9300 w. Jour Assn of Engng Socs—July, 1903. No. 57449 C.

Engineering English. T. J. Johnston. Criticism on the use of the English language by engineers. 2000 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57-416 D.

Proper Qualifications of Electrical Engineering School Graduates, from the Manufacturer's Standpoint. L. A. Osborne. Considers the more important and most noticeable qualities lacking in the average technical graduate. 1800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57412 D.

The Teaching of Physics to Engineering Students. W. S. Franklin. Suggestions and criticisms. 2000 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57-414 D.

Training an Artist in the Forces of Nature. E. H. Mullin. A discussion of the faults of present day technical education and its aims. 2800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57-415 D.

German Syndicates.

German Syndicates and Their Influence. A report on German trade in 1902 by Mr. Oppenheimer, Consul for Frankfort-on-Main. 4000 w. Ir & Coal Trds Rev—Aug. 14, 1903. No. 57490 A.

Government Ownership.

Should the Government Own or Control the Railroads? E. C. Nettels. Also, E. Wentworth. Two papers discussing this subject, especially in its bearing on American conditions. 7000 w. Pro Iowa Ry Club—June 16, 1903. No. 57428.

Labor.

American and British Workmen. A comparison, discussing the behavior and surroundings and their effect. 4700 w. Engng—Aug. 14, 1903. Serial. 1st part. No. 57491 A.

A Permanent Labor Court of Appeals. Gives a statement of the present industrial situation and the unsatisfactory methods of adjusting difficulties, and discusses the scheme of the Building Trades Employers' Assn., in New York. 2000 w. Gunton's Mag—Aug., 1903. No. 56863.

A Project for a Capitalized Labor Organization. C. L. Redfield. Suggestions for the establishment of business relations between capitalized labor and capitalized employers, instead of the present conflicting conditions. 3000 w. Engineering Magazine—Sept., 1903. No. 57367 B.

The Building Trades Employers and the Unions. William English Walling. An explanation of the situation in New York City, comparing it with the Chicago lockout of 1900. 2000 w. World's Work—Aug., 1903. No. 57073 C.

The Present Status of the American Labor Movement. John R. Commons. Discusses the question of organized labor and the recent disputes, and the future outlook. 3800 w. Rev of Revs—Aug., 1903. No. 57202 C.

The Union versus the Open Shop. Discusses the question of unionizing shops, and other demands made by union labor, the misuse of power, etc. 2800 w. Gunton's Mag—Aug., 1903. No. 56862.

Steel.

The Steel Situation in the States. Editorial discussion of the present situation as revealed in the annual report of the American Iron & Steel Assn., and of the danger of over-production and the effect it will have on British trade. 2400 w. Engng—July 4, 1903. No. 57023 A.

We supply copies of these articles. See page 157.

MARINE AND NAVAL ENGINEERING

Boat Lighting.

See Electrical Engineering, Illumination.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Marine.

Britain's Supremacy on the Atlantic. Editorial on the Cunard Steamship Company's agreement with the government, and the German high-speed vessels. 3300 w. Engng—Aug. 7, 1903. No. 57236 A.

Cavitation.

Cavitation with Screw Ships. J. A. Normand. Translated from *Comptes Rendus*. A study of the action of screw propellers. 1500 w. Marine Engng—Aug., 1903. No. 56890 C.

Destroyers.

Contract Trial of the United States Torpedo-Boat Destroyers Lawrence and Macdonough. Walter Ball. Illustration and description of the vessels, with report of trial. 4800 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57552 H.

Description and Trials of the U. S. Torpedo-Boat Destroyers Hopkins and Hull. Illustration, description, and account of trials. 15600 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57553 H.

Education.

The Education of Naval Engineers for Future Needs. Charles H. Manning. Showing that changed conditions have made necessary changes in methods of training, giving suggestions of some needed reforms. 2800 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57558 H.

Electric Power.

See Electrical Engineering, Power Applications.

Experiments.

Naval Engineering Research. Editorial on the United States' new naval engineering laboratory and its work. 2200 w. Engng—Aug. 14, 1903. No. 57496 A.

The Military Importance of Naval Engineering Experiments. George W. Melville. Emphasizes the importance of the work; discusses the establishment and equipment of the national experimental laboratory, and the advantages. General discussion. 12000 w. Pro Engrs' Club of Phila—July, 1903. No. 57457 D.

Graving Dock.

The New Graving Dock of the Kawasaki Dock-Yard Company, Kobe. An illustrated detailed description of the construction of a dock which accommodates vessels up to 5,000 tons. 4700 w. Engng—July 24, 1903. No. 57021 A.

Guns.

Making Big Guns. Lieut. Com. Albert Gleaves. Comments on the great advances in naval equipment, describing the making of modern large guns, and giving information concerning the results obtained with them. Ill. 4400 w. World's Work—Sept., 1903. No. 57563 C.

Houseboats.

The Houseboat for Summer Outings. Illustrated descriptions of recent types, some self-propelled. 1500 w. Marine Engng—Aug., 1903. No. 56894 C.

Lake Navigation.

Problems of Lake Transportation. Lieut. W. H. Frost. Shows the need of improvement on present methods and considers some subjects in navigation which all masters of vessels should understand, and suggests ways of instituting changes. 5000 w. Marine Rev—Aug. 6, 1903. No. 57136.

Launch Motors.

Modern American Launch Motors. W. P. Stephens. Reviews the history of the propulsion of small boats by steam, and the later developments resulting in the naphtha launch, the gas engines of various types, and the electric motor. Ill. 6000 w. Cassier's Mag—Aug., 1903. No. 57280 B.

The Petrol Racing Launch "Napier." Illustrated description. 2400 w. Auto Jour—Aug. 15, 1903. No. 57475 A.

Lifeboat.

A Steam Lifeboat. An illustrated description of a steam lifeboat, named the Princess of Wales, recently constructed for the Government authorities of the Isle of Mauritius. 1800 w. Engng—Aug. 14, 1903. No. 57492 A.

Monitors.

A Comparison of the Performances of the Monitors Arkansas, Florida, Nevada, and Wyoming. R. E. Carney. The chief points of difference in these vessels are in the character of boilers installed and the design of propellers fitted to the shafts. 2500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57556 H.

Oil Fuel.

Ocean-Going, Oil-Burning Tug Dauntless. Illustrates and describes a vessel recently launched in San Francisco. Open-hearth steel is used throughout. 1000 w. Marine Engng—Aug., 1903. No. 56889 C.

Power.

Powering of Ships. Theodore Lucas.

We supply copies of these articles. See page 157.

Considers methods of determining the power needed for a vessel. 1300 w. Naut Gaz—Aug. 6, 1903. No. 57139.

Resistance.

Experiments on the Resistance of a Screw Steamer in Free Route. H. Enno van Gelder Translated from *Schiffbau.* An account of dock experiments to measure the reaction of the pressure of the propeller on he water at different speeds, made at Kinderdyk, with the steamer "Vlaardingen. Ill. 2000 w. Marine Engng—Aug., 1903. Serial. 1st part. No. 56892 C.

Rivet Holes.

Drilled Holes. A discussion of Mr. Yarrow's paper on "Drilled v. Punched Rivet Holes in the Hulls of Ships." 3000 w. Engr, Lond—July 24, 1903. No. 57026 A.

Sailing Vessels.

The Old American Sailing Packets and Clipper Ships. John H. Morrison. Brief review of these early vessels and their development to meet the conditions of the times. Ill. 1500 w. Naut Gaz—Aug. 6, 1903. No. 57140.

Screw Propellers.

A Problem Connected with the Screw Propeller. W. F. Durand. Gives a mathematical solution of the problem of determining the speed when the ship and propeller and turning moment on the shaft are given. Other problems are also considered. 3000 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57560 A.

Screw Propulsion for Naval and Maritime Purposes. George Quick. A paper based on the study, observation and experience of many years. 8500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57551 H.

Shafting.

On Screw Shafts. John List. Read at the Engng. Con. of the Inst. of Civ. Engrs. Also discussion. Considers the wear or corrosion of shafting, and matters related. 2400 w. Marine Engng—Aug., 1903. No. 56888 C.

Shipwrecks.

Why Vessels Lose Their Bearings and Strand. John Maurice. On errors due to the use of the floating or patent log near land. 1000 w. Marine Rev—Aug. 20, 1903. No. 57509.

Steamships.

Fine Transatlantic Freighters. Brief description with illustrations of the "Mississippi" and the "Massachusetts." 700 w. Naut Gaz—Aug. 6, 1903. No. 57137.

New Steamer Calvin Austin, for the Eastern Steamship Company. Illustrates and describes a new vessel for the Boston-Portland service. 1500 w. Marine Engng—Aug., 1903. No. 56893 C.

Novel Ore Carrier. Illustrated description of the steamer Grangesberg, constructed by an English firm for the Baltic ore trade. She carries her own discharging gear with her. 1200 w. Marine Rev—Aug. 6, 1903. No. 57135.

Steamship Monroe of the Old Dominion Line. An illustrated detailed description of a recently completed vessel for service between New York and Norfolk. A steel screw steamer of the hurricane-deck type. 5500 w. Marine Engng—Aug., 1903. No. 56886 C.

The Baden Steamboat "Stadt Meersburg" (Der Badische Bodensee-Dampfer "Stadt Meersburg"). H. Courtin. An illustrated description of a new side-wheel boat for use on the Lake of Constance in connection with the service of the Baden State Railways. 3500 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 18, 1903. No. 57300 D.

The Twin-Screw Steamship Kaiser Wilhelm II. (Der Doppelschraubendampfer Kaiser Wilhelm II.). W. Kaemmerer. A general illustrated description with numerous illustrations from working drawings of hull and engines. Two articles. 6000 w. 4 plates. Zeitschr d Ver Deutscher Ing—Aug. 1 and 8, 1903. No. 57306 each D.

Submarines.

Official Trials of the Submarine Boats Plunger, Porpoise, and Shark. Daniel S. Mahoney. An account of the trials. 6500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57559 H.

Tonnage.

Registered Tonnages and Their Relation to Fiscal Charges and Design. James Maxton. Read before the Inst. of Nav. Archts. Discusses the British tonnage laws, and the essentials of an equitable basis for the levying of dues. 3500 w. Engng—July 24, 1903. No. 57025 A.

Torpedo Boats.

Care of Torpedo Boats in Reserve. G. C. Davison. Showing that attention and operation are essential for efficient maintenance. 6500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57554 H.

Some Experiences with the U. S. Torpedo Boat Goldsborough. H. G. Leopold. Gives an account of the conditions which caused shipbuilders a loss of over $2,000,000, and the failure of three firms, with facts and information of the trials made to secure the maximum speed guaranteed by the contractors. The causes of the failure of the machinery, with illustrations. 8400 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57555 H.

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Towboats.

Towboats on Western Rivers. Illustrates and describes the towboats used on the Ohio and Mississippi rivers to transport coal. 900 w. Marine Engng—Aug., 1903. No. 56887 C.

Turbine Steamer.

New Cross-Channel Turbine Steamer. Consular report concerning the steamship "The Queen," with articles from the Parsons Marine Steam Turbine Co. 1400 w. U S Cons Repts, No. 1736—Aug. 29, 1903. No. 57565 D.

The Turbine Steamship "Queen" (Le Paquebot à Turbines "Queen"). A. Dumas. An illustrated description of the new Parsons turbine steamer on the Calais-Dover service. 1200 w. Génie Civil—Aug. 1, 1903. No. 57313 D.

Yachts.

The Fruits of Cup Racing. Winfield M. Thompson. An illustrated article reviewing the various cup defenders, and the races, and commenting on the material progress and the sentiment due to the sport. 7000 w. Rudder—Aug., 1903. No. 57000 C.

The Modern Racing Yacht as an Engineering Proposition. W. P. Stephens. Showing that the modern racing yacht is entirely a development of bridge design in structure, and of marine powering in propulsion. 3000 w. Engineering Magazine—Sept., 1903. No. 57363 B.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol Motors.

Theory of the Alcohol Motor. C. C. Longridge. Shows the advantages of the combined cool cycle and high compression, and the beneficial influence of water. 2000 w. Engr, Lond—Aug. 7, 1903. No 57240 A.

Carbureters.

Carbureter Troubles and Remedies. Considers forms of carbureters, the action, troubles and the remedies. 4000 w. Automobile—Aug. 22, 1903. No. 57507.

Gasoline Motors.

A Combined Exhaust-Valve and Igniter for Gasoline Motors. Illustrated description of a novel arrangement fitted to the motors of the Duryea gasoline automobiles. 1000 w. Sci Am Sup—Aug. 15, 1903. No. 57198.

Gordon-Bennett.

The Race as I Saw It. W. J. Morgan. An illustrated account of the Gordon-Bennett race in Ireland. 3300 w. Auto Mag—Aug., 1903. No. 56861 C.

Light Cars.

The Renault Light Cars. An illustrated detailed description. 1000 w. Autocar—Aug. 1, 1903. No. 57104 A.

Hill Climbing.

The Laffrey Hill Climb. An illustrated account of the trials and results, giving details of interest. 3000 w. Autocar—Aug. 15, 1903. No. 57474 A.

Locomotives.

Compound Road Locomotive. Illustrates and describes a machine shown at the Royal Agricultural Society's exhibition. 800 w. Engr, Lond—Aug. 7, 1903 No. 57241 A.

Lubrication.

Cylinder and Crankshaft Lubrication E. W. Walford. On the lubrication of motor-car engines, considering the oiling of the gudgeon pin, the supply of lubricant, and experiments with graphite. 1400 w. Autocar—Aug. 15, 1903. No. 57473 A.

Mercedes.

The 1903 Mercedes Models. An illustrated detailed description. 2800 w. Auto Jour—Aug. 1, 1903. Serial. 1st part. No. 57103 A.

Municipal Vehicles.

The Use of Motor Vehicles for Municipal Purposes. Abstracts of two articles published in the *Contract Journal*, of London, giving an account of experience in their use in England. 4000 w. Eng News—Aug. 13, 1903. No. 57272.

Petrol Car.

The 1903 Oldsmobile Petrol Car. Illustrated detailed description of a small powered car to be sold at a moderate price. 3300 w. Auto Jour—Aug. 8, 1903. Serial. 1st part. No. 57217 A.

Speed.

Speed and Public Safety. Dr. Louis Bell. Considers problems in connection with the operation of automobiles and electric cars. 2500 w. Elec Rev, N. Y.—Aug. 15, 1903. No. 57255.

Standardization.

Standardization—Its Progress and What It Means to the Motorist. Considers its advantage to the owner and repairer, aid to repetition work, etc. 4000 w. Automobile—Aug. 8, 1903. No. 57102.

Steam Lurries.

The Invaluable Steam Lurry. Brief illustrated descriptions of modern vehicles

of English make. 1700 w. Auto Jour—July 25, 1903. No. 57013 A.

The Musker Steam Motor-Wagon. Illustrated detailed description. 2200 w. Engng—Aug. 7, 1903. No. 57235 A.

Tool.

A Useful Combination Tool for Motorists. Illustrates and describes the Dalton combination tool, showing the detachable parts separately and in different useful forms. 2000 w. Auto Jour—Aug. 8, 1903. No. 57218 A.

Touring.

How to Run a Rambler Touring Car. Extracts from a pamphlet, giving suggestions to the user of gasoline cars. Ill. 2200 w. Automobile—Aug. 22, 1903. Serial. 1st part. No. 57508.

HYDRAULICS.

Air Lift.

Air Lift Plant at the San Antonio Abad Cotton Mills in the City of Mexico. Juan Cuyas. Illustrated description, with results of tests. 1000 w. Compressed Air—Aug., 1903. No. 57201.

The Raising of Water from Deep Wells and Borings by Compressed Air. William H. Maxwell. Read at meeting of the British Assn. of Water-Wks. Engrs. The writer's views of the special circumstances to which this system is particularly applicable, reviewing the general principles governing the work, and giving details of the plant at Tunbridge Wells. 2700 w. Engr, Lond—Aug. 14, 1903. No. 57500 A.

Hydro-Electric Plants.

See Electrical Engineering, Generating Stations.

Plumbing.

I. The Art and Practice of Lead Burning by Aero-Hydrogen and Coal Gas. Charles Henry Mills. II. The Various Details of Work that Plumbers Have to Execute in and on a Large Size Dwelling-House. A. E. Edwards. Two prize essays which received the silver and bronze medals at the Regent-Street Polytechnic, London. Ill. 4000 w. Plumb & Dec—Aug. 1, 1903. No. 57169 A.

Screen.

Drift Screen on the Wien River at Weidlingau (Die Holzrechen-Anlage in den Hochwasserbehältern des Weinflusses bei Weidlingau). A. Swetz. Detailed description of the grating for the interception of drift and floating debris at the river protection works on the Wein near Weidlingau, Austria. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—July 31, 1903. No. 57328 D.

Tanks.

Storage Tanks. The first of two articles illustrating and describing the most approved practice to meet varying conditions. 2000 w. Met Work—Aug. 22, 29, 1903. Serial. 2 parts. No. 57401.

Water Power.

See Electrical Engineering, Generating Stations.

Water-Wheels.

Tangential Water-Wheel Efficiencies. George J. Henry, Jr. An illustrated article discussing shapes of buckets, particularly the ellipsoidal as compared with the general form of the Pelton bucket. 4500 w. Engr, U S A—Aug. 15. 1903. No. 57252 C.

MACHINE WORKS AND FOUNDRIES.

Architecture.

Factory and Warehouse Architecture. A. K. Adler in Michigan *Technic*. The present article deals with the general planning and construction. 2500 w. Ir Trd Rev—Aug. 13, 20, 1903. 2 parts. No. 57243.

Blueprints.

A Rapid Blueprint Frame. John Randol. Illustrates and describes the blueprint frame invented by Charles H. Wills. 1200 w. Am Mach—Aug. 13, 1903. No. 57179.

Boring Mill.

Boring and Turning Mill for Electric Generators. Illustrates and describes a boring and turning lathe made for large dynamo work. 1200 w. Engng—Aug. 14, 1904. No. 57495 A.

Castings.

Castings in Modern Construction. D. Macdougal. A short paper on the making of steel castings. 900 w. Pro Engrs Soc of W Penn—June, 1903. No. 57463 D.

Fluxing Metals for Casting. Walter J. May. Suggestions and general information on the use of fluxes. 1500 w. Prac Engr—Aug. 7, 1903. No. 57221 A.

Porous Brass Castings. C. Vickers. Discusses the cause of leaky castings, and suggests means of remedying the trouble. 1700 w. Am Mach—Aug. 6, 1903. No. 57153.

Spelter Castings and Some Difficulties Encountered in Their Manufacture. Winslow Goodwin, in *The Metal Industry*. Discusses the question of why spelter is not more generally used. 2000 w. Foundry—Aug., 1903. No. 57432.

Coil Forming.

Universal Forming Machine for Armature Coils. H. Robinson. Illustrations showing a newly designed machine for forming armature coils to the required and proper shape for different sizes of armatures. 500 w. Am Mach—Aug. 20, 1903. No. 57288.

Coloring.

Coloring of Metals. From the French

of M. Paul Malherbe, in *La Revue des Produits Chemiques.* Describes processes of coloring by oxidation, and by sulphuration, with processes of deposit of a metal. 2300 w. Sci Am Sup—Aug. 8, 1903. No. 57172.

Cranes.

Notes on Crane Design—Load Brakes. A. D. Williams. Illustrates and describes several designs of load brakes. 2000 w. Am Mach—Aug. 20, 1903. No. 57287.

Cupolas.

Cupola Linings. Walter J. May, in the *Mechanical World.* An illustrated article referring to British cupola practice. 1800 w. Foundry—Aug., 1903. No. 57430.

Cutting Tools.

Cuting Tools for Planer and Lathe. W. J. Kaup. Abstract of a lecture delivered at Pratt Institute, Brooklyn. A discussion of important points in the use of these tools. Ill. 2500 w. Mach, N Y—Aug., 1903. No. 57079 C.

Electrical Works.

The Edison Interests at West Orange, N. J. An illustrated description of the extensive works where some of the inventions of Thomas A. Edison are manufactured. 2500 w. Elec Rev, N Y—Aug. 8, 1903. No. 57150.

The Schuckert Electric Works at Nuremberg, Germany. S. N. Taylor. An illustrated article describing these fine works and their equipment. 2200 w. Elec Wld & Engr—Aug. 1, 1903. No. 57089.

The Westinghouse Works, Manchester, G. R. Dunell. A finely illustrated article, giving detailed description of those fine engineering works and their equipment. Also gives particulars of some of the principal manufactures. 14500 w. Trac & Trans—Aug., 1903. No. 57211 E.

Electric Driving.

See Electrical Engineering, Power Applications.

Forgings.

Drop Forgings. Dwight Goddard. Explains the making of drop forgings. 2000 w. Pro Engrs Soc of W Penn—June, 1903. No. 57462 D.

Some Characteristics of Good Forgings and Some Things to Avoid. James H. Baker. 1200 w. Pro Engrs Soc of W Penn—June, 1903. No. 57461 D.

Steel Forgings. T. D. Lynch. Notes some of the characteristics of steel forgings. 1500 w. Pro Engrs' Soc of W Penn —June, 1903. No. 57460 D.

Gages.

Making Spherical End Gages. Charles W. Wright. Illustrates and describes inventions of the writer for grinding spherical end gages, and a lapping rig for gages. 900 w. Am Mach—Aug. 13, 1903. No. 57178.

Grinding Lathes.

Removing Stock in the Grinding Lathe. Henry Hess. Gives results of some competitive trials to determine the relative efficiency of two wheels. 2500 w. Am Mach—July 30, 1903. No. 56884.

Inspection.

Inspection and Quality of Product in Piece Work. Translated from the *Gewerblich-Technischer Ratgeber.* Describes methods of testing and forms of penalties for bad work. 2500 w. Am Mach—Aug. 13, 1903. No. 57180.

Locomotive Works.

Shops of the Locomotive & Machine Company of Montreal. Ilusturated detailed description of works with a capicity of about 300 locomotives a year. Also general business in machine and structural work. 1500 w. R R Gaz—Aug. 21, 1903. No. 57544.

The Tools and Methods of a Swiss Locomotive Works. C. R. King. An illustrated description of the Swiss Locomotive and Machine Works at Winterthur, showing the union of English, American, and Continental practice there found. 3500 w. Engineering Magazine—Sept., 1903. No. 57364 B.

Machine Shops.

The West Allis Plant of the Allis-Chalmers Company. An illusutrated detailed description of an important industrial plant and its operation. 2800 w. Eng Rec —Aug. 22, 1903. Serial. 1st part. No. 57527.

Mechanical Drawing.

Mechanical Drawing and Its Relation to Practical Shop Work. L. D. Burlingame. An address before the Eastern Manual Training Assn. Considers the drafting department as the interpreter *to* the shop, *of* the shop, and *for* the shop. 4000 w. Am Mach—July 30, 1903. No. 56885.

Railway Shops.

See Railway Engineering, Permanent Way and Buildings.

Shop Systems.

Shop and Sales Systems of the C. W. Hunt Co. John Calder. Charts and explanatory notes. 1200 w. Ir Trd Rev—Aug. 6, 1903. No. 57147.

Steel Castings.

The Small Converter for Steel Castings. Arthur Simonson. On the advantages of the small converter processes, especially for small castings. 2200 w. Ir Trd Rev—July 30, 1903. No. 56883.

Steel Construction.

Advance in Modern Steel Construction. L. F. W. Hildner. A short paper on the

improved methods in shops where structural steel is made. 2000 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57458 D.

Taps and Dies.

The Action of Taper Taps—Relieving Taps and Dies with Acid. Wolfra M. Fox. Suggestions from the experience of the writer. 1500 w. Am Mach—Aug. 6, 1903. No. 57155.

Tool-Boxes.

Wall Tool-Boxes. John Randol. An illustrated description of the Cowles' toolbox, showing its convenience. 2200 w. Am Mach—Aug. 6, 1903. No. 57154.

MATERIALS OF CONSTRUCTION.

Alloys.

The Light Aluminum Alloys. Dr. Joseph W. Richards. Read before the Am. Soc. of Test Materials. States the qualities of pure aluminum, and gives information in alloying with zinc, copper, nickel, magnesium, tilanium, tungsten, chromium, manganese and silver. 5500 w. Ir Age—Aug. 13, 1903. No. 57176.

Carborundum.

The History of Silicon Carbide (Zur Geschichte der Siliziumkarbide). Ed. Donath. A review of the historical development of compounds of silicon and carbon, showing that silicon carbide, or carborundum, was first described by Colson in 1882. Two articles, 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 1, 8, 1903. No. 57335 each D.

Cast Iron.

A Microscopic Study of Cast Iron. Percy Longmuir. An examination of typical cast irons, reproducing characteristic structures, and giving notes on heat treatment for the production of "black heart" and malleable cast iron. 2700 w. Page's Mag—Aug., 1903. No. 57520 B.

Inspection.

Hints on the Inspection of Steel. Albert Moritz. Hints and suggestions of what is required of inspectors of material for the government. Gives methods of making tests, methods of manufacture, etc. 10800 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57550 H.

Iron.

See Civil Engineering, Materials.

Metallography.

The Metallography of Iron and Steel. H. M. Howe. The first of a series of papers discussing the methods of investigating the real nature of the principal materials of construction by the methods of microscopical study. 4000 w. Engineering Magazine—Sept., 1903. No. 57361 B.

Nickel Steel.

Consequences of the Theory of Nickel Steels (Conséquences de la Théorie des Aciers au Nickel). C. E. Guillaume. A discussion of the possible relations of the peculiarities of nickel-steel alloys to the transformations in the state of the iron. 1000 w. Comptes Rendus—July 6, 1903. No. 57342 D.

High Grade Nickel Steels. The last chapter of a lengthy article by Mr. Dumas in the *Annales des Mines*, in which the author indicates the possible applications of the special steels. 6800 w. Bul International Ry Cong—July, 1903. No. 57-444 E.

Nickel Steel for Purposes of Construction. Ralph H. Watson. Considers the properties that recommend this material, the uses to which it is applied, and gives tabulated results of tests. 2400 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57459 D.

Nickel Steel: Its Properties and Applications. Albert Ladd Colby. Extract from a paper read at meeting of Am. Soc. for Test. Materials. Compares its physical properties with carbon steel, and gives information and general review. 4200 w. R R Gaz—Aug. 14, 1903. No. 57266.

The Theory of Nickel Steels (La Theorie des Aciers au Nickel). C. E. Guillaume. An exhaustive review of nickel-steel alloys, with especial reference to the magnetic and thermal properties, including the experiments of the author, as well as of Curie, Osmond, Le Chatelier, and others. Two articles, 10,000 w. Rev Gen des Sciences—July 15, 30, 1903. No. 57307 each D.

The Theory of Nickel Steel (Sur la Theorie des Aciers au Nickel). C. E. Guillaume. A classification of the thermal and magnetic properties of nickel-steel alloys with a view of establishing a theory for the observed phenomena. 1200 w. Comptes Rendus—June 29, 1903. No. 57339 D.

Pig Iron.

See Mining and Metallurgy, Iron and Steel.

Steel.

Cold Rolled Steel. J. J. Crane. Considers the properties of this material, and its treatment. 1500 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57465 D.

Testing.

See Civil Engineering, Materials.

Tests.

Tests of Cast Steel Locomotive Parts on the Northern of France. M. du Bosquet. Translated from the *Revue Generale des Chemins de Fer.* Gives report of tests and results. 700 w. R R Gaz—July 31, 1903. No. 57046.

Tool Steels.

Notes on High-Speed Tool Steels.

Henry H. Suplee. Notes representing officially verified data of daily work. Ill. 1000 w. Inst Mech Engrs—July, 1903. No. 57125 D.

The New Tool Steel and Its Effect on Machine Shop Methods. Prof. C. I. King. Traces the development of tool steels, and the recent discovery which greatly increased the efficiency of the product, and results. 2500 w. Wis Engr—June, 1903. No. 57441 D.

MEASUREMENT.

Dynamometer.

A New Hydraulic Belt Dynamometer. Victor L. Sheldon. An illustrated detailed description of the machine, explaining principle upon which it is based and its use. 2000 w. Am Mach—Aug. 13, 1903. No. 57177.

Friction.

The Experimental Laws of Sliding Friction (Sur les Lois Experimentales du Frottement de Glissement). H. Chaumat. A mathematical discussion of the results of experiments upon the friction of polished discs, sliding without lubrication. 1200 w. Comptes Rendus—June 29, 1903. No. 57338 D.

Planimeter.

A New Integrating Planimeter, with a Proof of the Theory of Planimeters as Applied to the Integrating Pattern. Ill. 2000 w. Feilden's Mag—Aug., 1903. No. 57278 B.

Temperatures.

The Radiation Scale of Temperature and Its Realization up to 2,300 Degrees Absolute. O. Lummer and E. Pringsheim. From the *Berichte der Deutschen Physikalischen Gesellschaft.* Explanation of a new method of measuring high temperatures, giving experimental investigations made. 3000 w. Elect'n, Lond—Aug. 7, 1903. No. 57230 A.

Tension.

Tension Failure Phenomena, Their Meaning and Cause. Rudolph Hartman. Considers phenomena noted in tension tests, giving a list of the men who developed the "Theory of Elasticity" and the dates of their work. Ill. 12000 w. Wis Engr—June, 1903. No. 57440 D.

POWER AND TRANSMISSION.

Air Compressors.

The New Compressors of the Granby Company at Phoenix. George E. Cole. An illustrated detailed description of a recent installation in British Columbia. 1500 w. B C Min Rec—Aug., 1903. No. 57131 B.

Coal Handling.

See Gas Works Engineering.

Coal Hoist.

See Electrical Engineering, Power Applications.

Friction Clutch.

A New Form of Friction Clutch. Prof. H. S. Hele-Shaw. States the object of a friction clutch and the conditions involved, giving illustrated descriptions of various classes, and applications. 3700 w. Inst Mech Engrs—July, 1903. No. 57124 D.

Liquid Fuel.

See Mechanical Engineering, Steam Engineering.

Rope Driving.

Some Notes on Rope Driving. States the leading features of a rope drive and gives the most modern practice bearing upon these chief points. 1200 w. Prac Engr—July 31, 1903. No. 57114 A.

Ropeway.

A Wire Ropeway in the Anaimalai Hills. Horace H. Gass. Illustrates and describes a new ropeway for the transport of valuable lumber through inaccessible parts of Southern India. 3000 w. Page's Mag—Aug., 1903. No. 57523 B.

The Ore-Carrying Wire Ropeway at Vivero, Spain. Illustrates and describes an installation to convey iron-ore from the mines to the coast. 1500 w. Sci Am—Aug. 1, 1903. No. 57051.

Sources of Energy.

Natural sources of Energy. Dr. Louis Bell. Reviews the fuel situation, discussing other sources of power, and the probable extensive development of solar power in the future. 4500 w. Cassier's Mag—Aug., 1903. No. 57281 B.

SPECIAL MOTORS.

Alcohol Motors.

French Tests of Alcohol Motors. Capt. C. C. Longridge. Gives a table of the results with a view to indicating some method of comparison, and points of investigation. 1500 w. Engr, Lond—July 24, 1903. No. 57028 A.

See also Mechanical Engineering, Automobiles.

Diesel Motor.

An Oil Engine Central Station. Howard S. Knowlton. Illustrates and describes the new electric light plant at Jewett City, Conn., the first central station in the United States to adopt the Diesel oil-burning engine as its source of motive power. 1800 w. Am Elect'n—Aug., 1903. No. 57086.

Diesel.

The Diesel Engine. H. Ade Clark. A statement of principles and development, with account of performance of a motor at Harrogate in comparison with the steam

We supply copies of these articles. See page 157.

engine. 6300 w. Inst Mech Engrs—July, 1903. No. 57122 D.

Gas Engines.

The Gas Engine and Its Future. Briefly reviews the history of gas engines, considering the details of the large-unit class and its applications, in order to determine its suitability for power stations and its present position. 1700 w. Elec Rev, Lond—Aug. 7, 1903. Serial. 1st part. No. 57226 A.

The Gas Engine as a Pumping Medium. D. Hastings Irwin. Presented at meeting of British Assn. of Water Works Engrs. Considers the internal combustion engine as a means of effecting economy in pumping. 3800 w. Jour Gas Lgt—Aug. 4, 1903. No. 57216 A.

Power Gas.

Mond Gas and Its Relation to Large Power Plants. H. G. H. Tarr. Revews the results thus far attained in connection with power plants. 1400 w. Engr, U. S. A.—Aug. 1, 1903. No. 57068 C.

STEAM ENGINEERING.

Binary Engines.

Large Waste Heat Engines. Franz Welz. Illustrates and describes the general scheme of such installations and discusses the advantages and disadvantages. 1800 w. Engr, U. S. A.—Aug. 1, 1903. No. 57066 C.

Blowing Engines.

Quarter-Crank Blowing Engines. Illustrations, with an explanation of the general design and scope of these engines. 1500 w. Engr, Lond—July 24, 1903. No. 57029 A.

Boiler Inspection.

Technical features of the Work of the Bavarian Boiler Inspection Society (Die Technischen Hauptergebnisse der Tätigkeit des Bayerischen Dampfkessel-Revisions-Vereines). J. Reischle & Chr. Eberle. A review of the society's reports, showing the influence of the data determined by boiler inspection upon steam boiler design. 8000 w. Zeitschr d Ver Deutscher Ing—July 18, 1903. No. 57302 D.

Boilers.

Size of Boilers. Charles L. Hubbard. Gives tables and data relating to the overall dimensions of various types of boilers. 2200 w. Engr, U. S. A.—Aug. 1, & 15, 1903. Serial. 2 parts. No. 57067 each C.

The Care of Locomotive Boilers. M. E. Wells. Second prize paper. On the damage boilers suffer from the lack of proper care. General discussion. 13700 w. Pro Pacific Coast Ry Club—July 18, 1903. No. 57426 C.

The Development of the Yarrow Boiler for Use in Battleships. William Crush. An illustrated article tracing the growth and development from 1887 to the present time. 3500 w. Jour Am Soc of Nav Engrs—Aug., 1903. No. 57557 H.

The Management and Working of Boilers. Horace Boot. Abstract of a paper read at the convention of the Incor. Munic. Elec. Assns., on the cleaning, inspection and testing of boilers, repairs, attention and general management. Based on experience at Tunbridge Wells. 4000 w. Mech Engr—July 25, 1903. No. 57016 A.

Condensing System.

The Reorganization of the Condensing System of the Manhattan Station. Explains why the system first installed was not satisfactory and gives an illustrated description of the changes made. The new apparatus has given satisfactory results. 1800 w. Power—Aug., 1903. No. 56865 C.

Engines.

Rebuilding an Engine. W. H. Wakeman. Describes details in connection with the repair of a second-hand engine. Ill. 2200 w. Engr, U. S. A.—Aug. 1, 1903. Serial. 1st part. No. 57070 C.

The Griffin Marine Type Hydro-Oil Engines. Illustrated, detailed description of two marine oil-engines having features of special interest. 1600 w. Engng—July 24, 1903. No. 57022 A.

The Westinghouse Vertical Marine Type Engine. An illustrated description of an engine designed to meet the requirements of the isolated plant at the Union Ry. Station at Pittsburg, Pa. 2700 w. Power—Aug., 1903. No. 56870 C.

Engine Testing.

A Few Points on Engine Testing. An interview with Mr. George H. Barrus. 3000 w. Engr, U. S. A.—Aug. 1, 1903. No. 57069 C.

Feed-Water.

Feed-Water Heaters. William Wallace Christie. Illustrates and describes examples from current American practice. 3000 w. Cassier's Mag—Aug., 1903. No. 57282 B.

Horse-Power.

Horse-Power of English and American Boilers, and Chimneys. George G. Bennett. Read before the Ohio Soc. of Mech, Elec. & Steam Engrs. Discusses past and present standards, boilers, efficiency of chimneys, and related subjects. 3800 w. Engr, U. S. A.—Aug. 15, 1903. No. 57251 C.

Liquid Fuel.

Coal and Oil Fuel Compared. George E. Walsh. Considers the question of transportation in its bearing on fuel sup-

ply, and thinks oil will be more and more used. Discusses various sides of the fuel problem. 2300 w. Power—Aug., 1903. No. 56868 C.

Liquid Fuel. Illustrated detailed description of Kermode's system, stating its advantages. 2000 w. Engrs' Gaz—Aug., 1903. No. 57113 A.

Oil Burning Utilities and Futilities. Amanda T. Jones. The present article discusses the question of whether atomization previous to ignition is necessary, giving the writer's views. 3200 w. Steam Engng—Aug. 10, 1903. Serial. 1st part. No. 57144.

Pipe Coverings.

Experiments on the Efficiency of Non-Conducting Coverings for Steam Piping. W. N. Bolam and T. Grieve. An account of experiments carried out in the engineering laboratory of Edinburgh University, with summary of results. 1500 w. Engng—Aug. 7, 1903. No. 57234 A.

Power Plants.

Mechanical Plant in the Newark, N. J., Free Public Library. Illustrates and describes plant for furnishing light, heat and ventilation, power for elevators, book lifts, &c. 2000 w. Elec Rev, N. Y.—Aug. 15, 1903. No. 57256.

Power Plant Design. R. W. Stovel. Calls attention to details of plants, considering the requirements, and the apparatus usually installed. 5000 w. Pro Engrs' Soc of W Penn—June, 1903. No. 57466 D.

Power Plant of the Snellenburg Building. Walter Lewis Fleisher. Illustrates and describes the plant of a Philadelphia department store where peculiar conditions were imposed by the enlargement of the building. 2700 w. Steam Engng—Aug. 10, 1903. No. 57143.

Pulverized Coal.

The Burning of Pulverized Coal. C. O. Bartlett. Considers the requisites of success and the cost of securing them, and the advantages. 1800 w. Jour Assn of Engng Socs—July, 1903. No. 57452 C.

Regulators.

Regulators for Low Pressure Steam-Heating (Die Regulatoren für Niederdruck Dampfheizungen). E. Ritt. Illustrating a variety of automatic devices for controlling the steam pressure by regulating combustion. 2000 w. Gesundheits-Ingenieur—July 31, 1903. No. 57333 B.

Separators.

Internal Separators for Steam Boilers. R. T. Strohm. Illustrates and describes various devices for drying the steam, discussing their advantages and disadvantages. 1800 w. Am Electrn—Aug., 1903. No. 57085.

Steam Shovels.

Improvements in Steam Shovels. Waldon Fawcett. Notes the increase in the capacities and other phases of the development. Ill. 2200 w. Sci Am—Aug. 1, 1903. No. 57050.

Stuffing Box.

The Schwabe Stuffing Box (Die Schwabe-Stopfbüchse). J. Finkle. Describing an improved metallic packing for piston-rod stuffing boxes, with a method of testing the efficiency by use of the indicator. 1200 w. Zeitschr d Ver Deutscher Ing—July 18, 1903. No. 57303 D.

Superheating.

A Contribution to the Study of Superheating (Contribution à l'Etude de la Surchauffe). A. Petot. A discussion of the formulas for superheated steam, showing the necessity for a more satisfactory determination of the specific heat at various temperatures. 1200 w. Comptes Rendus—July 20, 1903. No. 57343 D.

Mechanical Features in the Use of Superheated Steam. Editorial pointing out some of the relations of superheated steam to mechanical details in stationary and locomotive engines and boilers. 2000 w. Ry Age—Aug. 14, 1903. No. 57245.

The Cruse Controllable Superheater. Illustrates and describes a superheater which claims to have solved the difficulties found in other types. 2400 w. Engng—Aug. 14, 1903. No. 57494 A.

The Present State of the Theory of Superheated Steam (Etat Actuel de la Theorie de la Surchauffe de la Vapeur). H. Bernard. A review of the formulas of Witz, Poincaré and Rupprecht for computing the economy due to various degrees of superheating. 2000 w. Genie Civil—July 25, 1903. No. 57311 D.

MISCELLANY.

Aeronautics.

Dynamic Flying Machines. Herr W. Kress. Abstract of a paper read before the Aeronautical Congress. 1000 w. Autocar—Aug. 1, 1903. No. 57105 A.

Disinfection.

Disinfection by Steam (Ueber Dampfdesinfekteon). Drs. Kister and Weichardt. Advantages and disadvantages of superheated steam for disinfection and sterilization of clothing and other materials. Diagrams and tables. Serial. 2 parts. 2500 w. Gesundheits Ing—June 30 and July 10, 1903. No. 56947 B.

Farm Machinery.

The Revolution of Farm Machinery W. B. Thornton. An illustrated article showing the great progress made in farm machinery and the changes in agricultural methods. 3000 w. World's Work—Aug., 1903. No. 57072 C.

We supply copies of these articles. See page 157.

Heating.

The Brückner System of Rapid Circulation Heating (Neue Schnellumlaufheizung System Bruckner). J. Einbeck. Describing a system of hot-water heating in which the circulation is accelerated by the use of a steam jet. 2500 w. Gesundheits Ingenieur—July 20, 1903. No. 57331 B.

Loom.

The New Automatic Hattersley Loom. Illustrates and describes a loom claiming to be perfectly automatic or self-feeding in regard to the weft yarn. Gives information concerning its operation. 1800 w. Sci Am Sup—Aug. 8, 1903. No. 57171.

Protection.

On the Preservation of Instruments and Machinery in Bengal. Paul Bruhl. Read before the Calcutta section of the Inst. of Elec. Engrs. On the preservation of machinery in hot and moist climates, considering the adverse influences. 4000 w. Engr, Lond—July 24, 1903. Serial 1st part. No. 57031 A.

Refrigeration.

The Scientific Results of the Munich Refrigeration Investigation Station (Die Wissenschaftlichen Ergebnisse der Münchener Kälte-Versuchstation). C. Linde. A review of tests of various ice machines, of liquid air and of special researches made from 1893 to 1900. 4000 w. Zeitschr d Ver Deutscher Ing—July 25, 1903 No. 57305 D.

MINING AND METALLURGY

COAL AND COKE.

Alaska.

The Kayak Coal and Oil Fields of Alaska. P. C. Stoess. Locates the district, describing the formations and deposits. 2000 w. Min & Sci Pr—Aug. 1, 1903. No. 57146.

Briquettes.

Fuel Briquetting. Considers the materials which may be used, the extent of the industry and methods and machinery used in Europe and Canada. Ill. 6500 w. Mines & Min—Aug., 1903. No. 57-004 C.

The Briquette Industry in France. Ed. Loze. Notes giving a general idea of the industry. 1400 w. Eng & Min Jour—Aug. 22, 1903. Serial. 1st part. No. 57535.

Coal Industry.

See Industrial Economics.

Heating Value.

The Relative Values of Coals and How to Burn Them. Jay M. Whitman. Gives information of capacities of various fuels measured in steam output, and suggestions for firing. 1200 w. Power—Aug., 1903. No. 56869 C.

Origin.

Some New Views on the Origin of Coal and Its Spontaneous Combustion, as well as on Firedamp Explosions (Einiges Neue über die Entstehung der Mineralkohlen und Ihre Selbstentzündung, sowie über die Schlagwetterexplosionen). F. Janda. A paleontological and chemical discussion. 5 parts. 10,000 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 13, 20, 27, July 4 and 11, 1903. No. 56949 each D.

Thick Seams.

Working a Thick Coal Seam in Bengal, India. Thomas Adamson. Describes a method by which it is claimed that ninety per cent. of the coal is obtained. Ill. 2400 w. Mines & Min—Aug., 1903. No. 57-006 C.

Washing Plants.

Coal Washing and Screening Plants. Illustrates and describes the Baum System and its working. 3800 w. Ir & Coal Trds Rev—July 24, 1903. No. 57035 A.

COPPER.

British Columbia.

See Mining and Metallurgy, Gold and Silver.

Concentration.

The Elmore Oil Concentration Plant. Arthur W. Sancton. Plan and description of the method and machinery used in concentrating copper ores at St. David's Mine, North Wales. 3000 w. Mines & Min—Aug., 1903. No. 57003 C.

Production.

World's Copper Production. A report of the last year's production in the various countries, comparing with the year previous. 1800 w. Engr, Lond—Aug. 7, 1903. 57242 A.

Queensland.

Mining in Northwest Queensland. Reginald A. F. Murray. Describes the formation, ores, &c., giving brief reports of some of the mines. The principal ores are silver, lead and copper. 1500 w. Aust Min Stand—July 2, 1903. Serial. 1st part. No. 57214 B.

Smelting.

Reverberatory Furnaces for Smelting

Copper. E. P. Mathewson. Brief illustrated description of the plant of the Washoe Copper Co., at Anaconda, Mont. 1100 w. Eng & Min Jour—Aug. 1, 1903. No. 57077.

GOLD AND SILVER.

British Columbia.

Boundary District of British Columbia. E. Jacobs. Information relative to the mines producing gold, silver, and copper ores. Ill. 4000 w. Eng & Min Jour—Aug. 22, 1903. No. 57533.

The Ore Deposits of Rossland, British Columbia. Bernard MacDonald. An illustrated description of this district, which is a large producer of gold-copper ore, and a study of the deposits. 2500 w. Eng & Min Jour—Aug. 8, 1903. No. 57184.

Canadian Practice.

Gold and Arsenic Recovery from Mispickel Ores. P. Kirkegaard. Describes the method of operation in a Canadian mill built with mortars suitable for inside amalgamation. 90 per cent. of the original gold was recovered. Also briefly describes the process of recovering the arsenic. 1000 w. Pacific C Min—Aug. 15, 1903. No. 57502.

Cyanide.

The Manufacture and Impurities of Commercial Cyandine. Alfred H. Allen. An important article explaining manner of detecting impurities. 1700 w. Eng & Min Jour—Aug. 15, 1903. No. 57264.

Use of Alkalies in the Cyanide Process. Ernest G. Sweetland. On the importance of using alkalies to overcome the effects of the acid, the methods of determining the amount necessary to add to the tailings, the merits of different alkalies, &c. 1000 w. Min & Sci Pr—July 25, 1903. No. 57065.

Determination.

The Iodometric Determination of Gold in Dilute Solution. Ralph N. Maxson. Gives results of experimental investigations. 1800 w. Am Jour of Sci—Aug., 1903. No. 57433 D.

Ecuador.

Gold Mining and Milling in Ecuador J. W. Mercer. Gives experience in the treatment of peculiar ores, describing mines, methods, &c. 3000 w. Eng & Min Jour—Aug. 15, 1903. No. 57262.

Mexico.

The Santa Eulalia District, Mexico. Robert T. Hill. An illustrated article giving the history, geology, and a detailed description of the development of these silver-lead mines. 3600 w. Eng & Min Jour—Aug. 1, 1903. No. 57075.

The Yaqui River Country of Sonora, Mexico. George J. Bancroft. An illustrated description of this district which is essentially a silver mining country, and of the country and mining conditions. 2700 w. Eng & Min Jour—Aug. 1, 1903. No. 57076.

Mother Lode.

The Banner Country of the Mother Lode. J. L. Bentley. Notes of present conditions in Amador County, California. Ill. 1800 w. Pacific C Min—Aug. 1, 1903. No. 57099.

New Mexico.

The Oregon Mining District. F. H. Lerchen. An illustrated description of the region, with special reference to the Modoc mine, N. Mexico. The ores are lead-silver and copper-silver. 2400 w. Mines & Min—Aug., 1903. No. 57001 C.

Ore Treatment.

The Treatment of Sulpho-Telluride Ores at Kalgoorlie. W. A. Pritchard and H. C. Hoover. Describes the treatment of refractory ores by the Diehl Process, and by the Roasting Process, comparing the results. 2500 w. Eng & Min Jour—Aug. 1, 1903. No. 57074.

Placers.

Placer Mining in Southern Oregon. Dennis H. Stovall. An illustrated account of the hydraulic mines and their methods. 1000 w. Min & Sci Pr—Aug. 15, 1903. No. 57515.

Rock Crushing.

I. A System of Crushing Rock in Stages by Wet Process and Suggestions as to How this Object Can Best be Achieved. Edward D. Chester.

II. A Further System of Crushing Rock in Two Stages, by Dry Process, with High-Class Cross-Grinding Rolls. Wegerif Type. Two papers with discussion. Ill. 7400 w. Jour Chem & Met Soc of S Africa—June, 1903. No. 57220 E.

Slimes.

The Desulphurization of Slimes by Heap Roasting at Broken Hill. E. J. Horwood. Abstract from *Trans.* of the Australian Inst. of Min. Engrs. Describes the ores and the treatment given. 2700 w. Eng & Min Jour—Aug. 22, 1903. No. 57532.

Stamp Mills.

New Method of Feeding Water to the Battery. Bernard MacDonald. Describes a novel method of introducing the feed water into the mortar of the stamp mill. Ill. 1500 w. Pacific C Min—Aug. 1, 1903. No. 57098.

Sulphides.

The Treatment of Broken Hill Sulphides. Alec A. Beadle. Considers the complex sulphide ores in which lead, zinc and silver constitute the most important

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ingredients. 1800 w. Eng & Min Jour—Aug. 8, 1903. No. 57182.

Victoria.

The Charlotte Plains Consolidated Gold Mines Company. An illustrated description of the plant, report of progress, &c. 2300 w. Aust Min Stand—June 18, 1903. No. 57011 B.

Yukon.

White Horse District, in Yukon Territory. William M. Brewer. Reviews the history, geology, present conditions, and future prospects of the mining industry. Map and editorial. 5500 w. Mines & Min—Aug., 1903. No. 57007 C.

IRON AND STEEL.

Blast-Furnace Gas.

The Utilization of Blast-Furnace Gases for Power Purposes. Charles Kirchhoff. Traces the development of the gas engine and discusses the use of waste furnace gas, presenting some of the principal engine designs. Ill. 4000 w. Jour Fr Inst—Aug., 1903. No. 57436 D.

Blast Furnaces.

Blast Furnace Capacity Rapidly Increasing. Information given by the American Iron & Steel Assn., showing that blast furnaces are to be increased 2,000,000 tons the present year, and 2,500,000 tons next year. 2000 w. Ir Age—Aug. 27, 1903. No. 57562.

Temperature Reactions in the Blast Furnace. Horace Allen. Gives diagram showing the variations which occur, with notes. 800 w. Engr, Lond—July 24, 1903. No. 57027 A.

Blowing Engines.

See Mechanical Engineering, Steam Engineering.

Cast Iron.

See Mechanical Engineering, Materials.

Coke Ovens.

Beehive Coke Ovens. Gives plans, specifications, and costs of ovens as constructed recently in Indiana Co., Pa. 1700 w. Mines & Min—Aug., 1903. No. 57002 C.

Elba.

The Iron Industry on the Island of Elba (Die Eisenindustrie auf der Insel Elba) Fr. Poech. An account of the iron mines and furnaces. Map and geological sections. 4000 w. Oesterr Zeitschr f Berg- u Hüttenwesen—July 4, 1903. No. 56-950 D.

Limonites.

Origin of the Oriskany Limonites. J. E. Johnson, Jr. A record of facts and observations taken principally from the Virginia brown ore fields, giving an explanation of the occurrence of these ores. 3000 w. Eng & Min Jour—Aug. 15, 1903. No. 57261.

Mesabi.

Notes on Recent Work on the Mesabi Iron Range. Dwight E. Woodbridge. Information concerning the exploration work on this range. 1000 w. Eng & Min Jour—Aug. 8, 1903. No. 57186.

Ores.

Iron Ores of Arctic Lapland. Chase S. Osborn. From a paper read before the Lake Superior Min. Inst. Describes the mines, methods of mining, extent of deposits and their character, giving information about cost, transportation and related matters. 4000 w. Ir Trd Rev—Aug. 20, 1903. No. 57512.

The Iron Ore Deposits of Lorraine (Das Lothringsche Eisenerzlager). Dr. O. Lang. A geological study of the important ore deposits of the district, showing the extensive developments of the last decade. Two articles. 3 plates. 7000 w. Glückauf—July 11, 18, 1903. No. 57336 each D.

Pig Iron.

How to Determine the Quality of Pig Iron. S. B. Patterson. Read before the New England Found. Assn. Considers the influences exerted by the ordinary elements and treatment. 3500 w. Foundry—Aug., 1903. No. 57431.

Smelting.

Considerations Favorable to Hot-Blast Smelting. Abstract from a pamphlet issued by the Colorado Iron Works Co., dealing with details of smelting practice and equipment. 2500 w. Min & Sci Pr—Aug. 15, 1903. No. 57514.

Steel.

See Mechanical Engineering, Materials.

Steel Castings.

See Mechanical Engineering, Machine Works and Foundries.

Steel Making.

See Electrical Engineering, Electro-Chemistry.

Steel Trade.

See Industrial Economy.

MINING.

Dredge Mining.

Dredge Mining in British Columbia. William M. Brewer. Discusses briefly the causes of the unsatisfactory results obtained. 1500 w. B C Min Rec—Aug., 1903. No. 57132 B.

Drilling.

Oil Well Drilling. An illustrated description of a fine drilling outfit and a synopsis of its operations. 3000 w. Met Work—Aug. 8, 1903. No. 57061.

Electric Hoisting.

See Electrical Engineering, Power Applications.

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Electric Power.

See Electrical Engineering, Power Applications.

Filling.

New Methods of Filling in the Goaf in Germany. From the report of Herr Williger, printed in the Report of the Prussian Commission on the Fall of Stone and Coal in Mines. Illustrates and describes the methods used, stating the advantages and difficulties and giving information of interest 6000 w. Ir & Coal Trds Rev—Aug. 7, 1903. No. 57233 A.

Fires

Underground Fires. F. W. Hardwick. Read before the International Fire Prevention Congress. Discusses the dangers, causes and means of prevention of mine fires. 5700 w. Col Guard—July 31, 1903. No. 57120 A.

Hoisting.

Some Notes on Certain Underground Hoisting Problems on the Witwatersrand. A. W. K. Peirce. A general statement of the conditions, concluding that the best method is the combination of poly-phase transmission, concession to direct currents for each hoist unit, and the "voltage control" of Leonard system. 2200 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57402 D.

Igneous Rocks.

Igneous Rocks: How to Identify Them Charles J. O'Brien. Describes the more common igneous rocks, giving practical hints for identifying them without microscopical examination. 1800 w. Min & Sci Pr—July 25, 1903. No. 57063.

Improved Appliances.

Improved Appliances, &c., Introduced Into German Mines in 1902. From *Zeitschrift für Berg-Hütten- und Salinenwesen.* Illustrated descriptions. 1400 w. Col Guard—Aug. 14, 1903. Serial. 1st part. No. 57488 A.

Management.

Real Values in Mine Management. Charles H. Fitch. Discusses some considerations by which management can be judged. 2000 w. Min & Sci Pr—Aug. 8, 1903. No. 57244.

Mexico.

From Parral to Guadaloupe y Calvo, Chihuahua, Mexico. H. Z. Osborne. An interesting account of a mule-back trip through this mineral district. Ill. 2800 w. Min & Sci Pr—July 25, 1903. No. 57064.

Mine Gases.

Some Mine Gases: Their Toxicology and Possible Connection with Miners' Phthisis. A. Heymann. Discusses the effects of higher oxides of nitrogen and carbon monoxide. 5800 w. Jour Chem & Met Soc of S Africa—June, 1903. No. 57219 E.

Mine Locomotives.

Pneumatic and Electric Locomotives in and about Coal Mines. A. S. E. Ackermann. Abstract of paper read before the Inst. of Min. Engrs. Brief comparison of the working of the two systems. 1200 w. Elect'n, Lond—Aug. 14, 1903. No. 57486 A.

Mine Plans.

Mine Plans, Their Preparation and Use. J. D. Kendall. Read before the Inst. of Min. & Met. The present article discusses the preparation of plans and what they should show. 1700 w. Min Rept—Aug 20, 1903. Serial. 1st part. No. 57505.

Mine Water.

Water in the Mines of Cripple Creek. Victor G. Hills. Describes the distribution of water in the mines of this district. A valuable contribution to the data covering the occurrence of water in veins. 3300 w. Eng & Min Jour—Aug. 8, 1903. No. 57183.

Ores.

Pisolitic and Concretionary Ores. A Selwyn Brown. Describes the peculiarities of these ores of iron, aluminum, nickel, manganese, etc., and gives explanations of their origin; gives also brief descriptions of deposits at various places. 3500 w. Aust Min Stand—June 18 & 25, 1903. Serial. 2 parts. No. 57012 each B.

Prospecting.

Prospecting and Valuing Dredging Ground with a Well Driller at Oroville, Cal. Newton Booth Knox. Slightly condensed from a paper read before the Inst. of Min. & Met. Gives briefly the history of this region and describes the operation of drilling, treatment, and calculating the values. 2500 w. Eng News—July 30, 1903. No. 57038.

Safety Apparatus.

Safety Apparatus for Underlie Shafts. Report on a fatal accident at Ravenswood (Queensland) with illustrated description of two simple appliances to prevent trucks from running away. 1800 w. Queens Gov Min Jour—June 15, 1903. No. 56-875 B.

Safety Lamps.

Safety Mining Lamps. Rufus J. Foster. Reviews the history of mine lighting from the earliest times, and the development of the Davy lamp, and the lamps of other inventors. Ill. 6200 w. Jour Fr Inst—Aug., 1903. No. 57437 D.

South Africa.

The Equipment of the Robinson Mine. Johannesburg. Edgar Smart. Discusses

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notable features of one of the largest mines in the Rand. Ill. 3800 w. Page's Mag —Aug., 1903. Serial. 1st part. No. 57-521 B.

Veins.

Cross-Vein Ore-Shoots and Fractures. W. H. Weed. Describes and explains the manner of formation. 900 w. Eng & Min Jour—Aug. 8, 1903. No. 57181.

Hydro-Thermal Activity in the Veins at Wedekind, Nevada. Henry C. Morris. Gives a general description of the mines and the encounter with warm water heavily charged with sulphureted hydrogen, discussing the ore occurrence. Ill. 2700 w. Eng & Min Jour—Aug. 22, 1903. No. 57534.

Secondary Enrichment of Mineral Veins in Regions of Small Erosion. C. L. Herrick. Presents views of the writer, based on wide observation and study explaining the cause of the wide difference in the reliability of gold-bearing veins found in two parts of the same range. 2000 w. Min & Sci Pr—Aug. 15, 1903. No.57513.

MISCELLANY.

By-Products.

By-Products from Gas, Coke, and Pig Iron Manufacture. Information from the report of R. Forbes Carpenter. 2500 w. Col Guard—Aug. 7, 1903. No. 57232 A.

Diamonds.

Kimberley Notes. T. Lane Carter. Illustrated article containing information of interest concerning these important diamond mines. 3700 w. Eng & Min Jour —Aug. 15, 1903. No. 57263.

Geology.

The Sea and Mining. Prof. Arthur Lakes. Illustrations shown at the sea coast of manner of making and destruction of rocks by action of shell-fish and erosion. 2400 w. Mines & Min—Aug., 1903. No. 57005 C.

Mica.

Mica in Brazil. H. Kilburn Scott. Read before the Inst. of Min. & Met. Discusses its varieties, its uses, where it is obtained, and a description of the deposits and mines of Brazil. 5000 w. Mines & Min—Aug., 1903. No. 57009 C.

Quicksilver.

The Cinnabar Fields of Texas. David DeWitt Lawrence. An illustrated account of the Terlingua district and its development. 2000 w. Min Rept—Aug. 20, 1903. No. 57504.

Sapphires.

The Anakie Sapphire Fields. B. Dunstan. Information from the annual progress report of the acting-government geologist. Ill. 1500 w. Queens Gov Min Jour—June 15, 1903. No. 56874 B.

Separation.

The Separation of Vanadium, Uranium, and Radium from Carnotite. Dr. J. Ohly. Describes the treatment for the recovery of vanadium, radium, and uranium values. 1600 w. Min Rept—Aug. 6, 1903. No. 57101.

See Electrical Engineering, Electrochemistry.

Volcanoes.

Mud Volcanoes. Prof. Arthur Lakes. On present-day illustrations of mud flows and formations resembling some older ones in which mineral deposits have been found. Ill. 1000 w. Mines & Min—Aug., 1903. No. 57008 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Government Accident Bulletin No. 7. Substance of the seventh quarterly accident report of the Interstate Commerce Commission, with editorial. 2800 w. R R Gaz—July 31, 1903. No. 57048.

Express Scheme.

An All Stations Express Train. Diagrams and description of a scheme for obviating the stopping of local trains, devised by Prof. J. Brown. 1500 w. Sci Am Sup—Aug. 15, 1903. No. 57196.

Fast Runs.

Record Runs Between London and Brighton. Charles Rous-Marten. A report of test runs made to show that the tracts of interest, from a pamphlet of the trips could be made in 50 minutes, the time being really less than that. 1800 w. Engr, Lond—July 31, 1903. No. 57128 A.

The Great Western's Royal "Record" Run. Charles Rous-Marten. Gives details of what is claimed as the most remarkable run on record. 2700 w. Engr, Lond—Aug. 14, 1903. No. 57499 A.

Train Dispatching.

The Expert Train Dispatcher. From the *N. Y. Times*. An explanation of the work and great responsibility carried by the dispatcher. 2300 w. Sci Am Sup—Aug. 22, 1903. No. 57296.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air-Brakes on Mountain Grades. Ex-

Interstate Commerce Commission, showing the diversity of practice on different roads. 1500 w. R R Gaz—Aug. 7, 1903. No. 57163.

Car Lighting.

See Electrical Engineering, Illumination.

Circulator.

Sheedy Circulator for Locomotive Cylinders. Indicator diagrams, illustrating the effect of the invention, and the conditions that exist in the cylinders when the circulator is not in use, with explanatory notes. 900 w. Loc Engng—Aug., 1903. No. 57057 C.

Electric Locomotives.

Electric Locomotives for the Baltimore Tunnel. Illustrated description of a distinct advance in electric locomotive design. 900 w. Ry Age—Aug. 21, 1903. No. 57510.

Electric Locomotives on French Railways. From *La Nature*. Illustrates and describes the types adopted by the Orleans line, and the line of the West, and discusses their advantages under certain conditions. 1700 w. Sci Am Sup—Aug. 15, 1903. No. 57199.

Locomotive Frames.

The Locomotive Steel Frame and Its Repairs. A. W. McCaslin. Considers the locomotive cast steel frame and its defects. General discussion. 7500 w. Pro Ry Club of Pittsburg—April, 1903. No. 57425 C.

Locomotives.

Atlantic Type (4-4-2) Locomotive for the Baltimore & Ohio. Illustrated description of engines for use on heavy and fast passenger trains. 500 w. R R Gaz—July 31, 1903. No. 57045.

Culm Burning Passenger Locomotives. Illustrated description, with dimensions, of an engine of the 4-6-0 type of the Deleware & Hudson Co. 350 w. Am Engr & R R Jour—Aug., 1903. No. 56872 C.

Duplex Tank Locomotive. Sectional drawings of an engine described in a previous issue. The engine constructed for the Compagnie de Chemins de Fer Departementaux, by La Société Suisse, of Winterthur. 200 w. Engr, Lond—Aug. 7, 1903. No. 57239 A.

Express Engine, Bengal-Nagpur Railway. Illustration and principal dimensions of a six-wheels coupled express passenger locomotive. 400 w. Engr, Lond—July 31, 1903. No. 57130 A.

European Four-Cylinder Compound Locomotives. Abstract of a paper by Prof. von Borries, translated from the *Zeitschrift des Vereins Deutscher Ingenieure*, with critical review by Lawford H. Fry. 2400 w. Ry Age—Aug. 7, 1903. No. 57141.

German Locomotive Designs for High Speed Service. Lawford H. Fry. Illustrations and tabulated comparison of four prize designs, and illustrated description of Prof. von Borries' train design. 1400 w. R R Gaz—Aug. 21, 1903. No. 57547.

Recent Locomotive Construction in Germany. Illustrations with brief descriptions of interesting examples of freight and passenger engines. 1200 w. Ry & Engng Rev—Aug. 8, 1903. No. 57188.

Some Recent High-Speed Locomotives (Neuere Schnellzuglokomotiven). M. Weiss. Illustrated descriptions, mainly of European compound locomotives. 2 parts. 1 plate. 3500 w. Schweiz Bauzeitung—June 20 and 27, 1903. No. 56952 each D.

Locomotive Works.

See Mechanical Engineering, Machine Works and Foundries.

Main-Line-Traction.

See Street and Electric Railways.

Trucks.

Continental Types of High-Capacity Railway Trucks. From *Glückauf*. Illustrations, with brief descriptions. 500 w. Col. Guard—Aug. 7, 1903. No. 57231 A.

NEW PROJECTS.

Long Island R. R.

Atlantic Avenue Improvement on the Long Island Railroad. Outlines the future plans for this road, showing the importance of the removal of the surface tracks. Gives an illustrated description of the work. 1500 w. Ry Age—July 31, 1903. No. 57060.

Trans-Canadian.

The Grand Trunk Pacific Railway Legislation. Discusses notable features of the Grand Trunk Pacific bill, giving information in regard to the project. Also editorial. 3500 w. Ry Age—Aug. 7, 1903. No. 57142.

PERMANENT WAY AND FIXTURES.

Boston Station.

Back Bay Station, Boston; New York, New Haven & Hartford Railroad. Illustrates and describes a fine station built to serve the residential district. 2200 w. Ry & Engng Rev—Aug. 8, 1903. No. 57187.

Construction Cost.

The Cost of the Albula Railway (Die Kosten der Albulabahn). R. v. Reckenschuss. An abstract of the cost of the construction of the Albula railway in Switzerland, giving practical data as to the cost of Alpine railways. 2500 w. Zeitschr d Oesterr Ingn Arch Ver—June 28, 1903. No. 57325 D.

Grades.

Grade Reduction on the Illinois Central.

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Reviews the changes in progress on the different divisions. Map. 2500 w. R R Gaz—Aug. 14, 1903. No. 57269.

Reduction of Grade on Railroads. C. D. Purdon. Discusses questions bearing on the reduction of grades to secure economy in operation. 3000 w. Jour Assn of Engng Socs—July, 1903. No. 57450 C.

Location.

Some Theories Upon Railroad Location. J. G. G. Kerry. Abstract of a paper read before the Canadian Soc. of Civ. Engrs. Considers preliminary work, grades, curvature, etc. 5700 w. Eng News—Aug. 20, 1903. No. 57543.

Locomotive Works.

See Mechanical Engineering, Machine Works and Foundries.

Long Island R. R.

Progress of the Atlantic Avenue Improvement of the Long Island Railroad. An illustrated article showing work, nearing completion, to get the tracks of this road off grade on Atlantic Ave., Brooklyn. 1700 w. R R Gaz—July 31, 1903. No. 57047.

Railroad Building.

Feats of Modern Railroad Engineering. Henry Harrison Lewis. An illustrated account of difficult work, tunneling mountains, bridging chasms, etc. 2000 w. World's Work—Sept., 1903. No. 57564 C.

Rebuilding.

The Rebuilding of the Gulf & Ship Island. An account of this road and its reconstruction, with plan, map and illustrations showing the general scheme of the work. 1700 w. R R Gaz—July 31, 1903. No. 57044.

Shops.

The New Rock Island Shops at East Moline, Ill. An illustrated detailed description of these shops and their equipment. 2500 w. Ry Age—Aug. 21, 1903. No. 57511.

The Renovo Shops—Pennsylvania Railroad. Illustrates and describes improvements made in these shops, so far as completed. 1700 w. Ry Age—Aug. 14, 1903. No. 57246.

The Southern Pacific Shops at East Los Angeles. General plan and description. 1400 w. R R Gaz—Aug. 14, 1903. No. 57268.

Signalling.

An Audible and Visible Railway Signal for Grade Crossings, Operated by a High Tension Current. Emile Guarini. Illustration and brief description of a new system introduced by Siemens & Halske. 300 w. Sci Am—Aug. 15, 1903. No. 57194.

Switches.

Electro-Pneumatic Switches. Describes the plant recently installed at Bayonne, N. J., for the Central R. R. of New Jersey, for operating interlocking switches. Ill. 1200 w. Compressed Air—Aug., 1903. No. 57200.

Should Frogs and Switches Be Blocked? G. E. McCaughan. Also, J. H. Maher. Two papers considering the question of blocking. 6500 w. Pro Iowa Ry Club—June 16, 1903. No. 57427.

Terminal Station.

New Terminal Station at Chicago for the C., R. I. & P. Ry. and the L. S. & M. S. Ry. Illustrated detailed description of a station in which the tracks are elevated above the street level. 5500 w Eng News—Aug. 6, 1903. No. 57159.

Ties.

Experiments with Steel and Reinforced Concrete Ties. Illustrates and describes the experiments made by C. Buhrer on the L. S. & M. S. Ry. and on other roads. 3000 w. Ry & Engng Rev—Aug. 1, 1903. No. 57062.

The Life of Treated Ties. Samuel M. Rowe. Abstract from a pamphlet on "The Value of Treatment of Timber." 900 w. R R Gaz—Aug. 21, 1903. No. 57548.

STREET AND ELECTRIC RAILWAYS

Acceleration.

High Acceleration on Electric Railways. Results on the Liverpool Overhead Line. Herbert C. Fyfe. On the satisfactory results from the accelerated service introduced. 1400 w. Sci Am Sup—Aug. 22, 1903. No. 57297.

Berlin.

Alterations in the Train Service on the Berlin Metropolitan Electric Railway and Extension of the Line. Mr. Kemmann. Points out the alterations that have been made in the service of the main line and gives particulars regarding the extension towards the center of the city. Map. 4300 w. Bul International Ry Cong—July, 1903. No. 57443 E.

Car Tests.

Interurban Car Tests. W. E. Goldsborough and P. E. Fansler. An illustrated account of car tests made on the cars of the Union Traction Company of Indiana.

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10000 w. Trans Am Inst of Elec Engrs —July, 1903. No. 57411 D.

Construction.

Permanent Way Construction and Maintenance. Charles A. King. A summary of replies received to some seventy questions on track construction sent to different roads by the managers of the Glasgow tramways. 5000 w. St Ry Jour —Aug. 1, 1903. No. 57083 D.

Electric Locomotives.

See Railway Engng., Motive Power.

Electric Traction.

Mediterranean System of Electric Traction in the Neighborhood of Nice and Hydraulic Plant of Mesala. C. L. Durand. Brief illustrated description of one of the most extensive systems of electric traction in Europe. 2200 w. Elec Rev, N. Y.— Aug. 8, 1903. No. 57149.

Electrification.

Electric Traction on the North-Eastern Railway. An illustrated detailed account of the extent of the scheme and of the manner in which it will be carried out. 2300 w. Engr, Lond—July 24, 1903. No. 57030 A.

Glasgow Tramways.

Glasgow Municipal Tramway Results. Editorial review of the report for the year ending with last May. 1800 w. Engng —Aug. 7, 1903. No. 57237 A.

Goods Traffic.

Carriage of Merchandise on Electric Tramways. Thomas Upton. Discusses this service in England, the inter-working with the railways, rates, etc. 2200 w. Elec Rev, Lond—Aug. 14, 1903. Serial. 1st part. No. 57481 A.

High Speed.

High Speed Electric Railway Problems. A. H. Armstrong. Considers some of the relations existing between first cost and probable cost of operation and schedule speed, discussing also the probable traffic receipts with different methods of operation. 5000 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57403 D.

High Speed Electric Railways. B. F. Bradford. Read before the Elec. Assn. of N. S. W. Considers some of the problems bearing upon the earning capacity and design of a projected interurban railway, and methods for their solution. 3700 w. Aust Min Stand—July 16, 1903. Serial. 1st part. No. 57467 B.

Interurban.

Denver & Northwestern Interurban Road for Hauling Coal. Illustrates and describes the coal mines and plant, the track and overhead construction, equipment, passenger operation, etc. 3000 w. St Ry Jour—Aug. 1, 1903. No. 57082 D.

Electric Interurban Between Columbus and Zanesville. Illustrated detailed description of a road under construction on a private right of way. Also of the portion of the road which has been in operation more than a year, and its equipment. 5800 w. St. Ry Jour—Aug. 1, 1903. No. 57080 D.

Electric Lines in Northern New York State. An illustrated article dealing with the territory between Albany and Buffalo. 3500 w. R R Gaz—Aug. 21, 1903. No. 57546.

Railway Development in Queens County. An illustrated description of the system of the N. Y. & Queens Co. Ry. which has recently passed under new ownership and of the territory it serves. 4000 w. St Ry Jour—Aug. 22, 1903. No. 57518 D.

The Economy of a Typical American Interurban System. Percival E. Fansler. Report of a comprehensive test of the entire system of the Union Traction Co. of Indiana, to determine the actual working efficiency of the different energy-transforming devices. 3200 w. Elect'n, Lond —Aug. 14, 1903. Serial. 1st part. No. 57484 A.

Italy.

The Milan-Gallarate Electric Railway. P. Letheule. Brief illustrated description of this electric railway line and its operation. 1500 w. Elec Wld & Engr—Aug. 1, 1903. No. 57091.

Leipzig.

Street Railways at Leipzig. A report of concessions, operation, equipment, and management of the electric street railways. 2200 w. U S Cons Repts, No. 1724—Aug. 15, 1903. No. 57168 D.

Light Railways.

Hampshire Electric Light Railways. Illustrated detailed description of an interesting system of electric railways recently completed in England, and the equipment. 1800 w. Tram & Ry Wld—Aug. 6, 1903. No. 57222 B.

Locomotives.

Storage Battery Industrial Locomotives. F. L. Sessions. An illustrated article considering the equipment of a storage battery locomotive. 3700 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57409 D.

London.

The Central London Railway. H. F. Parshall, E. Parry, and W. Casson. An account of various tests made during the first three years' working. Illustrates and describes the equipment and the operation. An underground system worked on the continuous current principle with third rail. 7000 w. Trac & Trans—Aug., 1903. Serial. 1st part. No. 57213 E.

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Main-Lines.

Steam vs. Electric Traction for Main Line Railways (Vergleich zwischen Dampf und Elektrischer Traktion auf Vollbahnen). E. Cserháti. A discussion of the applicability of electric traction to main railways, based upon the experience with the Valtellina line in northern Italy. 4000 w. Glasers Annalen—Aug. 1, 1903. No. 57324 D.

Mine Locomotives.

See Mining and Metallurgy, Mining.

Newcastle.

Electric Traction as Applied to the Newcastle Tramways. A. E. L. Rossignol. Read before the Munic. Elec. Assn. Investigates the influence of additional capital expenditure on the cost of current at the tramway power station in Newcastle. 4000 w. Elec Engr, Lond—July 24, 1903. No. 57018 A.

Paris.

Rapid Transit in Paris. Daniel Bellet. Describes the legislation which rules in Paris under which passenger traffic is managed. First of two articles. 7000 w. Trac & Trans—Aug., 1903. Serial. 1st part. No. 57212 E.

The Power Plant for the Metropolitan Street Railway of Paris. Emile Guarini. Illustration of interior of plant, with descriptive notes. 3000 w. Sci Am Sup—Aug. 8, 1903. No. 57170.

Paris Underground.

Details of Construction of the Paris Underground Railway Beneath the Place de l'Opera. Brief illustrated description. 1000 w. Sci Am Sup—Aug. 22, 1903. No. 57299.

Performance.

Predetermination in Railway Work. F. W. Carter. Gives a method of determining performance of the ordinary continuous current railway motor, or motors having similar characteristics. 5500 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57413 D.

Power Stations.

See Electrical Engineering, Generating Stations.

Railway Kinematics.

Plotting of Speed-Time and Speed-Distance Curves from the Acceleration Speed-Curve. L. A. Freudenberger. An extension of the method of Mailloux for plotting curves for the construction of railway schedules from predetermined data. 1200 w. Elec Wld & Engr—Aug. 8, 1903. No. 57158.

Report.

Report on Mr. Young's Return Relating to Permanent Way Construction and Maintenance. Charles A. King. Read at Glasgow conference of the Municipal Tramways Assn. A summary of a report by John. Young, containing a great variety of information gathered from a large number of towns. 11000 w. Tram & Ry Wld—Aug. 6, 1903. No. 57223 B.

Single-Phase.

Electric Traction with Single-Phase Motors. Brief account of trials of running an electric car with single-phase currents, made at Milan by Dr. G. Finzi. 1200 w. Elect'n, Lond—Aug. 14, 1903. No. 57483 A.

Sleeping Car.

Plans of the Holland Sleeping Car. Illustrated description of a car intended for service on interurban lines, arranged to serve as a parlor car during the day and a compartment sleeper at night. 800 w. St Ry Jour—Aug. 15, 1903. No. 57251 D.

Steam vs. Electricity.

A Comparison of Steam and Electric Railway Returns. H. D. Emerson. Calls attention to points of interest brought out by the recently issued bulletin of the United States Census Office. 1800 w. St Ry Jour—Aug. 8, 1903. No. 57152 D.

Subway Cars.

Cars for the New York Subway. An illustrated description of the first shipment of cars built for the new subway. 2200 w. St Ry Jour—Aug. 22, 1903. No 57519 D.

Switzerland.

The Albula-Engadin Railway. Emile Rüker. An illustrated description of this line, emphasizing its importance in connection with the development of international traffic. 2000 w. Page's Mag—Aug., 1903. No. 57522 B.

Third Rail.

The Position and Protection of the Third Rail on Electric Railroads. William E. Langdan. Extracts from a paper read before the Engng. Con. of the Inst. of Civ. Engrs., London. Discusses the lack of uniformity in practice, and considers important points. 1500 w. R R Gaz —Aug. 21, 1903. No. 57545.

Trolley Insulators.

Some Recommendations Concerning Electrical and Mechanical Specifications of Trolley Insulators. Samuel Sheldon and John D. Keiley. Gives results of tests made on samples obtained in the open market and recommendations concerning specifications of certain types. Ill. 1800 w. Trans Am Inst of Elec Engrs—July, 1903. No. 57406 D.

Vesuvius.

The Vesuvius Railway (Die Vesuvbahn). H. Morgenthaler. Describing the electrical equipment of the new railway up Mount Vesuvius. 1800 w. Schweizerische Bauzeitung—July 25, 1903. No. 57330 B.

We supply copies of these articles. See page 157.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Cams.

The Drafting of Cams. By Louis Rouillion. Size, 8 by 5½ in.; pp. 23; figures, 16. Price (paper), 25 cents. New York: The Derry-Collard Co.

In spite of some inherent objections, cams are widely used in machines, such as harvesters, printing presses, sewing machines, looms and other mechanisms where it is necessary to convert circular into reciprocating motion, and a knowledge of the methods of laying them out is important for the mechanical draftsman. The present pamphlet, which is the second number of a series of practical papers now being issued by The Derry-Collard Co., contains plain and complete directions for designing and drawing cams of various forms for very many purposes. The illustrations are clear, and the whole pamphlet is well and attractively made, and will be useful to the student as well as to the practical designer of machinery.

Cars.

The Car Builders' Dictionary. An Illustrated Vocabulary of Terms Which Designate American Railroad Cars, Their Parts, Attachments, and Details of Construction. 1903 Edition. Compiled for the Master Car Builders' Association by Rodney Hitt, B. M. E., assisted by A. M. Waitt, J. S. Lentz and W. P. Appleyard. 12½ by 8½ in.; pp. iv, 525; illustrations, 4,974. Price, $5. New York: The Railroad Gazette.

The original idea of the Car Builders' Dictionary, begun by the Master Car Builders' Association in 1872, was to standardize car-building language, and the successive editions of the work have not only done this, but they have also been a most potent force in standardizing car-building itself. Since the issue of the enlarged edition of 1895, still another important and practical use has been found for the book, it now being employed, wherever there are railroads, as a guide in designing, specifying, and ordering cars. The present edition has been prepared with a view to facilitate its use for such purposes, and shows practically every standard type of freight and passenger cars, and the details of their construction. In general arrangement the lines of the 1895 edition have been closely followed, the book being divided into two general parts, the first 151 pages containing definitions, historical matter and specifications, and the last 374 pages containing the illustrations. The definitions are given in clear and concise language, and, in many cases, are amply descriptive. Wherever possible, references are given to the illustrations in the second section of the book, thus giving a complete alphabetical index to all the engravings as well as defining the terms and parts. In the illustrated pages are shown besides the numerous types of cars and their details, trucks and truck details, car furnishings, electric cars and trucks, together with the electrical machinery placed on them, the standards and recommended practice of the Master Car Builders' Association and car-shop machinery. The aim has been to show present approved practice only, nothing that is experimental and nothing that is going out of use. Particular attention has been paid to steel cars, and the illustrations show the latest types in great variety. Draft gears and brake apparatus have been particularly well illustrated with a large number of examples of the designs most used. Practically every detail of car furnishings is shown in a wide variety of designs. One new subject has been added, that of car-shop machinery. This deals with the machinery most commonly found in car shops and includes illustrations of wood-working machines, forging machines and pneumatic tools, now so largely used in steel car repairs. All these improvements help to make the work more than ever a standard reference book for all who are in any way interested in the rolling equipment of railroads.

Chimneys.

Chimney Design and Theory. A Book for Engineers and Architects. Second Edition, Revised and Enlarged. By William Wallace Christie. Size, 9 by 6 in.; pp. viii, 192; illustrations, 53. Price, $3. New York: D. Van Nostrand Company.

Since the first edition of this book was published, a few years ago, some notable chimneys have been erected and some new

methods of construction have been introduced, which are now illustrated and described. Advantage has also been taken of the opportunity afforded by the issue of a second edition to revise the book throughout, some twenty-five pages of text and twelve full-page illustrations having been added. Among the new subjects treated of is radial-brick construction, which is assuming increasing importance, and which is the construction employed for the tallest chimney in the United States, to date, lately erected at Constable Hook, N. J. The chapters of this edition are devoted, respectively, to: Introduction and history; theory of chimney draft; chimney formulæ; chimney tables, wind pressure, air space in grates; foundation materials, brick chimney materials; steel chimneys, theory pertaining to same and examples from existing structures; brick chimneys, with theory and examples; chimney performances, special types, straightening chimneys, flues; house chimneys; lightning protection; general information. Before the publication of this work, there had been very few books on the subject of chimneys, and these were practically out of date, so that the present volume, in which is gathered a great deal of information, hitherto widely scattered, and here treated in the light of the author's large experience, is a most useful one for both engineers and architects.

Earthwork.

Earthwork and Its Cost. By Halbert Powers Gillette, E. M. Size, 7¾ by 5½ in.; pp. x, 244; plates and figures in the text. Price, $2. New York: The Engineering News Publishing Co.

The question of the cost of earthwork is one of the most important which the engineer as well as the contractor is called upon to answer, and too often the answer is only a guess, which may or may not be right, but upon which both the reputation of the engineer and the profit of the contractor depend. In spite, however, of the importance of this subject, the available information on it has been in the form of scattered articles and papers and isolated tables, so that the present volume, which is the first one to treat of earth economics in a comprehensive way, and which contains practically all that is in print on the subject in American technical literature, as well as the substance of the author's own notes founded on his personal experience, is an extremely useful one. The facts and figures quoted are discussed and analyzed, with the aim of deducing rational methods and rules to be used in cost calculations, and the latest practice is described. All the styles of excavating, moving, and dumping earth are considered, from hand labor to the most modern steam shovels and incline conveyors. Besides the treatment of earthwork in general, there are chapters on such special kinds of earthwork as are involved in trenching and pipe laying, post holes, roads, etc., and others on hydraulic excavation, dredging, and rapid field and office survey work. The book is a thoroughly practical one all through, and will do much to put the estimation of the cost of earthwork on a solid basis.

Steam Engine.

A Handbook on the Steam Engine, with Special Reference to Small and Medium-Sized Engines. By Herman Haeder, C. E. Translated from the German by H. H. P. Powles. Third English Edition, Revised. Size, 7½ by 5 in.; pp. viii, 458; figures, 1,085. Price, $3 (10s. 6d.). New York: D. Van Nostrand Company. London: Crosby Lockwood & Son.

Since the first edition of this handbook appeared, the whole work has been carefully revised, and necessary corrections have been made. Tables have been extended and new matter added, particularly in the present English edition, which has been modified so as to more fully meet the requirements of English-speaking engineers, the dimensions being given, in almost every case, uniformly in inches. This volume is a very comprehensive and profusely illustrated handbook for the design of steam engines. Different sections are devoted to: Types of steam engines; details of steam engines; governors; valve gears; condensers, air pumps and feed pumps; examples of Continental engines; particulars of English engines; compound engines; indicators and indicator diagrams; calculations for power and steam consumption; effect of inertia on reciprocating parts; friction brake dynamometer; special reversing gears and other details; and boilers. There are many tables and diagrams, as well as an index, which all help to make the book a handy and useful one for engine makers, mechanical draughtsmen, engineering students and users of steam power.

BOOKS ANNOUNCED.

Practical Farm Drainage. Why, When and How to Tile Drain. By C. G. Elliott. Price, $1. New York. John Wiley & Sons. London: Chapman & Hall, Ltd.

The Alternating Current Transformer. By F. G. Baum. Price, $1.50. New York: McGraw Publishing Co.

Electrical Engineering, An Elementary Text Book. By E. Rosenberg. Translated from the German by W. W. Haldane Gee and Carl Kinzbrunner. Price, $1.50. New York: John Wiley & Sons.

The Art of Pattern-Making. By I. McKim Chase, M. E. Price, $2.50. New York; John Wiley & Sons. London, Chapman & Hall, Ltd.

NEWS SUPPLEMENT

The Engineering Magazine—October, 1903

Coming Society Meetings.

AMERICAN GAS LIGHT ASSOCIATION. Sec.: A. E. Forstall, 58 William St., New York. Annual convention, Oct. 21-23, at Detroit.

AMERICAN INSTITUTE OF ARCHITECTS. Sec.: Glenn Brown, Washington, D. C. Annual convention, Oct. 15-17, at Cleveland.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Regular meeting on fourth Friday of each month, except June, July and August, 12 W. 31st St., New York.

AMERICAN INSTITUTE OF MINING ENGINEERS. Sec.: R. W. Raymond, 99 John St., New York. Next meeting, October 13, at New York.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, Oct. 28, at Richmond, Va.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION. Sec.: L. C. Fritch, Monadnock Block, Chicago. Annual meeting, March 15-17, 1904, at Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Annual meeting, Dec. 1-4, at New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Sec.: Geo. W. Tillson, Municipal Building, Brooklyn, N. Y. Annual meeting, Oct. 20-22, Indianapolis.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday from October to May, inclusive.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Saturday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month, except July and August.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month, except July and Aug.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. Regular monthly meetings of the various sections on other days.

IOWA RAILWAY CLUB. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LEAGUE OF AMERICAN MUNICIPALITIES Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

NEW YORK RAILROAD CLUB. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July, and August, at Carnegie Hall, 154 W. 57th St., New York.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNALING CLUB. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct. 13, 14 and 15, at Kansas City, Mo.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY, NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Industrial Notes.

—The New York offices of the sales organization of the Westinghouse Electric & Manufacturing Company, consisting of the New York Sales Department, Department "I," the Export Department, and the general agent's office, have been removed to the new Hanover Bank Building, corner of Nassau and Pine Streets. The new offices occupy the entire seventeenth floor of this building, one of the finest and best equipped office buildings in the country, where the arrangements and facilities will be of the best, both for the representatives of the Company, and the public with whom they do business. The mail address of the several departments of the sales organization in New York will be No. 11 Pine Street. The telephone number, 6131 Cortlandt, remains unchanged. The executive, financial and stock transfer offices will remain on the fourth floor of the Equitable Building. The present organization of the Westinghouse Electric & Manufacturing Company has been quartered in the Equitable Building since 1889, but the rapid and material increase of business has made the above move necessary.

—The coal-handling machinery installed by the C. W. Hunt Company, of West New Brighton, N. Y., at the Lincoln Wharf power station of the Boston Elevated Railroad Company, recently lowered the world's record for rapid unloading. The coal was raised 90 feet above tide water and delivered to the storage pockets at the rate of 320 tons per hour. The installation fol-

lows in general design the standard Hunt steeple-tower rig, the moving gear and coal cracker being electrically driven, and the hoisting engine direct connected. The overhang of the folding boom is 40 feet, and the capacity of shovel 2 tons.

—The Haeseler pneumatic hammers, which the Ingersoll-Sergeant Drill Company is manufacturing, are meeting with general approval by those who have tested these tools. The "Axial Valve" mechanism used in the construction of the Haeseler hammers has produced a steady-working and unbreakable valve, thus eliminating the troubles common to pneumatic hammers in which the valve is of the straight-line reciprocating type.

—The Steamboiler Equipment Company of New York, of 20 W. Houston Street, New York, report the successful operation and acceptance of the "hydro-carbon" system as applied to the two new boilers lately erected in the United States Arsenal, at Frankford, Pa., in compliance with specifications calling for smokeless furnaces. They have also installed their system at the power house of the Bridgeton Traction Co., Bridgeton, N. J., at a plant of the Stanley Electric Mfg. Co., Pittsfield, Mass., and at the Rumford Chemical Works, Providence, R. I.

—The Heisler Mfg. Co. has let a contract to Wm. B. Scaife & Sons Co., Pittsburg, Pa., for a structural-steel machine-shop building, covering a total floor space of 25,560 square feet, to be erected immediately at St. Mary's, Ohio, for the manufacture of air compressors and pumping machinery. The selling and engineering office of the Heisler Mfg. Co. is located in the Westinghouse Building, Pittsburg, Pa.

—The Reeves Engine Co. expects, shortly, to more than double their manufacturing capacity. Among the numerous recent sales of the Reeves vertical cross-compound steam engines are two large direct-connected sets to the Providence Steel Casting Company, of Providence, R. I.

—The firm of Arthur Koppel has been awarded the contract for the building and equipping of a narrow-gauge railroad about 400 miles long by the Otavi Mining and Railroad Company. The railroad is to be used in the service of the copper mines in the district Otavj and Tsumeb in southwestern Africa. The total cost of building the road is approximately $4,500,000. The firm of Arthur Koppel has entered into relations with several of the large German banks to build this road, which has to be finished within two and one-half years. Arthur Koppel builds and equips the road complete, including rails, steel ties, rolling stock and all the other equipment. By one of the last steamers fifteen engineers of the firm left Hamburg for southwestern Africa in order to begin work.

—The National Fire Proofing Company has issued a catalogue, which, in appearance, size and character of contents, is like the standard engineering pocket-books. This volume consists chiefly of a selection of completed pages of an extensive work on fire-proof construction and materials, which will be published later and whose object, aside from serving as a more complete catalogue than the present book of the products of the National Fire Proofing Company, is to give the architect, the engineer, the builder, the insurance underwriter and all others interested reliable information concerning the fire-proofing of buildings by means of the various materials and methods in common use to-day, but more particularly by the use of the material known as porous terra cotta, the special product of most of the works of this company. The author of this treatise is Mr. Henry L. Hinton, the engineer of the company, and in the present hand-book, one of the chief features is an account of his new system of floor-arch construction, which he has called the "serrated arch." On account of the elaborate style in which this pocket-book has been issued, its price has been fixed at $3.

—The instruction of the American School of Correspondence is under the direction of members of the faculty of Armour Institute of Technology, and Dr. Gunsaulus, president of that institute, has given the work his enthusiastic support and personal supervision. Due credit will be given for the work covered by correspondence should the student later pursue his studies at the Institute. The instruction papers are prepared especially for home study, and are used as text-books by the Government in the School of Submarine Defense at Fort Totten, N. Y., and by the Westinghouse Electric and Manufacturing Company, of Pittsburg,

which is using over seven hundred of the papers in the "Shop School" maintained for its employees. The paper on "Storage Batteries" is used as a text-book for the senior class in electrical engineering at Columbia University. The American School of Correspondence has students within a few miles of the Arctic circle, in the Fiji Islands and in the Falkland Islands, off of Cape Horn. It has over three hundred students in New Zealand alone. Wherever knowledge of American enterprise has penetrated, there will be found correspondence school students.

—The plant of the American Roller Bearing Company, at 32-40 Binford Street, Boston, was totally destroyed by fire on Tuesday, Aug. 18, and the machinery and stock were entirely lost. Fortunately, however, this company had been making arrangements to get into a plant outside of Boston, and had already placed orders for new machinery which would enable them to double their capacity. They are now taking immediate steps towards getting this new plant into running shape and will, therefore, not be seriously delayed in accommodating their customers. With an entirely new and enlarged equipment, the American Roller Bearing Company should be in a better position than ever to handle a large business for the coming year.

—The St. Louis Portland Cement Co. entertained the members and friends of the St. Louis Railway Club recently. A special train was furnished by the Burlington Railway, which conveyed the party first to the extensive quarries of the Cement Company, where the Burlington bridge crosses the Missouri River, and then to the cement plant at Prospect Hill, in the extreme northern portion of St. Louis. After the works, which have been in operation since January 1, 1903, had been thoroughly inspected, refreshments were partaken of, and the party then returned to town again by the Burlington Route, whose service was complimentary.

—The affairs of the Chicago Pneumatic Tool Company are in a most flourishing condition, and the prospects are exceedingly bright for them to continue so in the future. The various plants are working increased forces in order to adequately fulfill the requirements. Their foreign offices report a correspondingly cheerful outlook. The business for the month of August exceeded that transacted in August, 1902, and there is every indication that the sales of pneumatic appliances for the month of September will be very satisfactory.

—One of the prime requisites for the successful business of to-day is to make quick deliveries, and the "when" is often considered of more importance than the "how much." To further facilitate the prompt filling of orders, the Sawyer-Man Electric Company have recently established a distribution depot at the Central Stores of the Terminal Warehouse, in West 28th Street, New York. Here are kept over a million lamps in stock, so that any and all calls may be speedily and completely answered. A similar depot is situated at 30th and Market Streets, Philadelphia, and others are located in Boston, Buffalo, Syracuse, Pittsburg, Charlotte, Chicago, Denver, St. Louis, Atlanta, New Orleans, San Francisco, Seattle, and other centers of trade.

—The industrial department recently established by the Erie Railroad Company has for its purpose the further development of the territory traversed by the railroad. The company seeks to increase the number of manufacturing plants on its system and to develop the natural resources and the commerce of its territory, so that the prosperity and growth of the towns on its lines may be augmented and the traffic returns of the company enlarged. The company's industrial department has all the territory traversed by the railroad districted in relation to resources, adaptibility, markets and advantages for manufacturing, and can advise with manufacturers in relation to the most suitable locations. The information furnished a manufacturer is reliable and has practical bearing on the nature of his particular industry. The company makes the resources and advantages along its line known in order to secure more industries, either through the influx of manufacturers about to establish new or branch factories, or through their creation by local enterprise, and makes the manufactured products of the line known in all markets. The company's lines traverse the States of New York, New Jersey, Pennsylvania, Ohio, Indiana and Illinois, all comprising a territory rich in resources and en-

terprise; many of the most important business centers are immediately upon its tracks; it has great ore docks at Cleveland and Buffalo, and its lines run through the steel manufacturing districts. The geographical location of the Erie Railroad is such as to form a world's thoroughfare quickly commanding all markets—United States and export. Vast deposits of anthracite and bituminous coal, oil, natural gas, sewer-pipe, fire and other clays, cement material, building stone and other minerals exist on the line. The cities on the Erie Railroad are highly enterprising and are thoroughly organized and prepared to treat with manufacturers. New manufacturing plants are constantly locating on the system and the development of local resources is rapidly going on. It is important in this age of modern facilities for manufacturers to locate where they can obtain side tracks so as to receive from and ship directly into cars at the factory. Information can be promptly furnished in this connection about every point on the system between New York and Chicago. The new industrial department is in charge of Luis Jackson, industrial commissioner, Erie Railroad Company, 21 Cortlandt Street, New York.

—The Ingersoll-Sergeant Drill Co. will double its present facilities for manufacturing in the pneumatic tool department. This enlargement is necessary on account of the increasing demand for the Haeseler "Axial Valve" pneumatic hammers.

—The recent great industrial activity has caused many manufacturers to build entirely new works, or at least to greatly extend existing plants. The well-known Pedrick & Ayer Company is one of the many concerns forced by the growth of their business to seek more commodious quarters. For several years this company occupied its own factory in Philadelphia, extending its rapidly growing line of air tools, while continuing its older line of special railroad tools and appliances in which the company gained its reputation. A site for the new modern works was purchased immediately adjoining the Clinton Avenue station of the Central Railroad of New Jersey at Plainfield, N. J. No expense has been spared in the construction and equipment of the buildings, which are all of brick and steel and of slow-burning construction. Good light for all buildings and departments has been especially sought, and convenience to excellent transportation facilities has also been carefully considered. The main building contains the offices of the company, draughting room, tool room and storage room for the principal raw materials and finished parts. The principal portion, however, is taken up by the machine shop proper, the fitting, assembling, testing and shipping departments. The main bay is provided with a 15-ton Shaw electric crane, equipped with three motors. Besides the main traveling crane there are numerous hoists and jib cranes actuated by compressed air. The machine tools are all driven by electric motors, the prevailing plan being to group several machine tools on one countershaft, this in turn being belted to a motor of fair size and efficiency. In the testing department proper arrangements are made to provide practical working conditions for the air compressors, portable and stationary riveters, hoists and cranes, which are produced in great variety and size. At the lower end of the main building a spur from the railroad extends three car lengths under the crane where rapid loading and unloading of machines and products is possible. The boiler and engine house, with fire wall and metal door between, might be considered as one building. The boiler room is well equipped with all necessary appliances dictated by modern usage and has substantial storage capacity for coal. The engine room contains a belted automatic air compressor of the type largely sold by the company, and two direct-connected dynamo-engine sets for supplying power and light to the entire works. The sets are of 150 kilowatts capacity each; the engines are furnished by the Ames Iron Works and the dynamos and switchboards by the General Electric Company. The blacksmith shop and pattern shop and storage house are equally well provided with the accessories for good, reliable, up-to-date work. In fact, the entire plant shows the desire of the Pedrick & Ayer Company to continue its well-established line and still have sufficient capacity to develop improvements for which the buying public is always ready.

—Reference has already been made, in these columns, to the "Technolexikon," the technical dictionary in English, French and

German, which the Society of German Engineers will publish as soon as the necessary matter can be gathered together and put into shape. While this society will bear all the expense of publication, it is hoped that technical societies and individuals in all countries will help to make this monumental work a complete success by sending the editor words, terms and expressions with which they are familiar. In March, 1901, this work was inaugurated by a publication which appeared in the journal of the Society of German Engineers, when the intention to publish such a comprehensive work was first made known generally, and shortly after that printed information was sent to technical societies and individuals in Germany and abroad, telling the ways in which contributions to the "Technolexicon" could be furnished by everybody in touch with the various industries and with technical and engineering work. Dr. Hubert Jansen, whose name has already become connected with other encyclopedic works, was elected editor in charge of this great new undertaking. An idea of the comprehensiveness of the work can be gained from the statement of Dr. Jansen that, although words have already been gathered for one and a half years by societies and individuals in Germany, Belgium, France, England and the United States, the collection will probably not be completed before the end of the year 1904, when the compilation of the contributions will begin, which will occupy about two years more, so that the manuscript will be ready probably by the end of the year 1906, after which it will go to the press. According to Dr. Jansen, not only contributions of technical terms with their translations are desired, but also such contributions which, besides giving the technical term, give, at the same time, an explanation showing in what sense or in what connection the term is used, and contributions of local expressions and customary phrases, as used in the technical language of the country, are highly appreciated. If terms, which are very uncommon, are communicated, it is requested that the derivation be given at the same time. The principal sources for the "Technolexicon" are of course these contributions, but catalogues, price lists and other printed matter of industrial firms, are also of great value, from which catalogues, etc., the technical terms can be gathered by the assistant editors and other collaborators of the editorial staff of the "Technolexicon" in Berlin, and it is highly desirable, therefore, in order to further the work of this dictionary, that all the manufacturing firms publishing catalogues, price lists, etc., send copies of their printed matter to the "Editor of the Technolexicon, Dr. Hubert Jansen, Berlin, N. W. (7), Dorotheenstrasse 49." This will be to the interest of such firms, as the "Technolexicon," once completed, will undoubtedly prove a most valuable help in the work of translating catalogues from one language into another. All those who desire to contribute to this great work through collecting terms and phrases, may apply for note books, especially arranged for that purpose, and for further information directly to Dr. Jansen, or to Dr. Alfred Mueller, of 150 Nassau Street, New York City.

—The New York sales offices of the Nernst Lamp Company have recently been removed from the Equitable Building to the new Hanover Bank Building, No. 11 Pine Street.

—Wm. B. Scaife & Sons Co., of Pittsburg, Pa., sole manufacturers of Scaife and We-Fu-Go water softening and purifying systems, will be represented in the future in Philadelphia by Mr. Duncan W. Patterson, M. E., with offices in the Harrison Building, corner 15th and Market Streets, in place of Mr. Fierstine, whose offices were in the Bourse Building. Mr. Patterson is thoroughly familiar with water purification in all its branches, and he will have charge of all the work of Wm. B. Scaife & Sons Co., in their water purifying department, in Eastern Pennsylvania, Southern New Jersey, Delaware, Maryland, and Virginia.

—The New York Continental Jewell Filtration Co. have recently sold their pressure filters to the following concerns: The Riverside Cotton Mills, Danville, Va.; J. A. Roebling & Sons Co., Trenton, N. J.; Women's College of Baltimore, Baltimore, Md.; American Ice Company, Frankfort, Pa.; Reymann Brewing Company, Wheeling W. Va.; C. W. Franzheim, Wheeling, W. Va.; Reid Plumbing Company, Fairmont, W. Va.; International Text Book Company, Scranton, Pa.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine When you write.

Boilers.

Pamphlet entitled "The Water-Tube Boiler in the American Mercantile Marine" being a reprint of a paper read before the Society of Naval Architects and Marine Engineers by William A. Fairburn. This pamphlet contains illustrated descriptions of various types of marine water-tube boilers and relates experience with them, and also discusses mechanical stokers and oil fuel. 9 by 6 in.; pp. 100. The Stirling Company, Chicago.

Blowers.

Publication No. 154, with illustrated description and price list of a cast-iron exhauster or volume blower direct connected to an electric motor of the protected type. 7 by 6 in.; pp. 4. American Blower Company, Detroit.

Condensing Apparatus.

Pamphlet treating of the condensation of exhaust steam by means of the cooling properties of saturated air, and illustrating and describing the Pennell saturated-air steam condenser, with results of tests. 10 by 7 in.; pp. 14. Arthur Pennell, 300 Heist Building, Kansas City, Mo.

Consulting Engineers.

Booklet, describing the organization and methods of a company which does a general consulting engineering business in all branches, making examinations and tests and furnishing reports. 6¼ by 3½ in.; pp. 12. Engineering Company of America, 74 Broadway, New York.

Correspondence School.

Illustrated catalogue, with detailed descriptions of many courses of instruction by correspondence, in a great variety of subjects, and lists of instructors and graduates. 9½ by 6¾ in.; pp. 184. American School of Correspondence at Armour Institute of Technology, Chicago.

Digging Machinery.

Catalogue for 1903, with descriptions and handsome half-tone illustrations of "orange-peel" and "clam-shell" buckets, dredges, railroad excavators, steel traveling derricks, skid excavators, coal-handling machinery, derrick fixtures, stationary coal bridge, and other kinds of digging and handling appliances. 9¾ by 6½ in.; pp. 143. The Hayward Company, 97-103 Cedar St., New York.

Drills.

Circulars Nos. 2 and 3, with illustrations and descriptions of portable universal radial drills and of plain radial drills. 9 by 6 in.; pp. 4. Roos & Mill, Cincinnati, Ohio.

Electric Apparatus.

Bulletins Nos. 3030 and 6005, devoted, respectively, to sewing-machine motor equipments for direct and alternating currents and to automatic circuit breakers for direct current, with descriptions and many illustrations. 11 by 8 in.; pp. 16. Western Electric Co., Chicago and New York.

Bulletins, with illustrations and descriptions, in French, of hydro-electric plants, generators, motors, lightning arresters, and other electric apparatus. 11½ by 8¾ in.; pp. 4 each. Compagnie de l'Industrie Electrique et Mécanique (Brevets Thury), Geneva, Switzerland.

Electric Driving.

Special publication No. 7008, a paper on "Electrically Driven Shops," by Robert L. Warner, which was presented at a meeting of the New England Railroad Club, and contains well illustrated descriptions of the application of electric motors to the driving of a great variety of machines. 9 by 6 in.; pp. 50. Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Bulletin No. 35, containing a well illustrated description of the new locomotive and car shops of the Lake Shore and Michigan Southern Railway at Collinwood, O., abstracted from the *American Engineer and Railroad Journal*. These shops have a complete electric power equipment for driving tools and for other purposes. 10 by 7½ in.; pp. 34. Crocker-Wheeler Co., Ampere, N. J.

Electric Meters.

Bulletin No. 1, with illustrations and comprehensive descriptions of the Duncan integrating wattmeter and its parts, and information about the installation, testing and maintenance of electric meters and useful tables. 9 by 6 in.; pp. 27. Duncan Electric Mfg. Co., Lafayette, Ind.

Electric Motors.

Publication No. 1044, devoted to small electric motors, with illustrations and descriptions of many kinds of alternating and direct-current motors and their application to a great variety of purposes. 10½ by 8 in.; pp. 60. Also bulletins devoted to various kinds of electric apparatus, and index to bulletins. General Electric Company, Schenectady, N. Y.

Bulletin No. 52, with illustrations and descriptions of the Stow multi-speed electric motors, in which the speed is varied by means of movable cores in the pole pieces, and views of various applications of these motors to driving machinery. 10 by 7 in.; pp. 32. Stow Manufacturing Co., Binghamton, N. Y.

Filtration.

Pamphlet, with description, illustrated with half tones and line cuts, of the filtration works of the East Jersey Water Company at Little Falls, N. J., on the Passaic River, which have a normal capacity of 32,000,000 gallons in 24 hours. 6 by 9 in.; pp. 36. The New York Continental Jewell Filtration Co., New York.

Locomotives.

Record of Recent Construction, No. 43, a pamphlet with tinted illustrations and descriptions in English and in French of a variety of locomotives for different kinds of service representing current requirements. 6 by 9 in.; pp. 32. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

Catalogue No. 36, with illustrated descriptions of patented perforated milling cutter for internal lubrication, milling machines, rotary planing machines, cutting-off machines, boring machines, drilling machines, and other kinds of tools for army, navy, railway and general machine-shop equipment. 9 by 6 in.; pp. 236. Newton Machine Tool Works, Philadelphia.

Mechanical Stoker.

Catalogue "C," with descriptions and illustrations of the Green traveling link grates for securing the progressive combustion of coal under boilers, views of plants where these stokers are installed, and tables giving analyses and other data of coal from all the fields of Pennsylvania, Ohio, Illinois, Indiana and Kentucky. 6½ by 9½ in.; pp. 35. Green Engineering Co., Chicago.

Mining Machinery.

Catalogue No. 19, with large, half-tone illustrations and descriptions of coal cutters and coal drills operated by electricity and compressed air; electric locomotives for mines and surface haulage; complete electric power plants for mining purposes; and coal-handling and washing machinery. 8 by 10 in.; pp. 127. The Jeffrey Manufacturing Co., Columbus, O.

Ore Mills.

Pamphlet, with illustrations and descriptions of the Kinkead ore mill, which has a rotating muller for grinding the ore in a steel pan, and other appliances by means of which the ore is crushed in an economical and efficient manner. 8 by 5¾ in.; pp. 20. Henshaw, Bulkley & Co., San Francisco.

Packing.

Booklet entitled "Points on Packing," with illustrations and descriptions of unvulcanized sheet-rubber packing, gaskets, gasket tubing, union rings, water-cock washers, discs, pump valves and other rubber packing products. 6¼ by 3½ in.; pp. 16. Jenkins Brothers, 71 John St., New York.

Pumps.

Pamphlet, entitled "Pump Data, No. 3," with illustrations and descriptions of the Aldrich vertical quintuplex electric pump, and table showing range of operation. 9 by 6 in.; pp. 8. The Allentown Rolling Mills, Allentown, Pa.

Refrigeration.

"Twentieth Anniversary Greeting," a pamphlet with many illustrations and comprehensive descriptions of complete systems of refrigerating and ice-making machinery for all purposes. 9 by 6 in.; pp. 177. Frick Company, Waynesboro, Pa.

Rubber Matting.

Catalogue, with illustrations, descriptions and prices of corrugated rubber matting, perforated rubber mats and other ornamental door mats, ornamental stair and car step treads, and other kinds of rubber mats and matting. 9 by 6 in.; pp. 24. Boston Belting Co., Boston.

Small Tools.

Catalogue No. 2, with illustrations, descriptions and price lists of taps and dies, die-stock sets, milling cutters, slitting saws, ratchet drills, lathe tools, tapping heads, boiler punches, reamers, taper pins, standard measuring machines, standard size and thread gauges, gauges for railway rolling stock and other special purposes, and other small and special tools. 7¼ by 4¾ in.; pp. 182. Pratt & Whitney Co., Hartford, Conn.

Stamp Mill.

Catalogue with illustrations and descriptions of the improved Parker rotary stamp mill for crushing ores, and of accessory machinery, together with useful tables and data. 8¾ by 5¾ in.; pp. 20. Rotary Mill & Mining Co., Seattle, Wash.

Steam Engines.

Catalogue, with descriptions, illustrated by half-tones and line cuts, of horizontal and vertical automatic high-speed steam engines and their accessories, and tables of dimensions and weights. 7 by 9 in.; pp. 34. New York Safety Steam Power Co., 113 Liberty St., New York.

Structural Work.

Pamphlet, with half-tone illustrations of machine shops, power stations, pier sheds, highway and railway bridges, and other examples of steel and steel-concrete structural work. 4¾ by 8 in.; pp. 47. Berlin Construction Company, Berlin, Conn.

Turbines.

Catalogue M, 1903, with illustrations and descriptions of the "New American" turbine, in many styles, turbine governors, and other water-wheel machinery, paper and pulp mill machinery, gearing, and power transmission machinery, together with results of tests, and tables and other useful information. 9 by 6 in.; pp. 98. Dayton Globe Iron Works Co., Dayton, O.

Unions.

Circular, with illustration and price list of Tuxeda unions for steam pipes. Also, circular illustrating and describing Merrill's "Ideal" twin strainer for condensing water for steam plants. 9½ by 6 in. Franklin Williams, 39 Cortlandt St., New York.

Well Machinery.

Cloth binder, containing various circulars with illustrations and descriptions of Challenge earth auger outfits; St. Louis center beam driller; standard walking-beam outfit for sinking oil, gas and artesian wells; drilling cables and sand lines; portable engines and boilers; and other kinds of well-sinking and drilling machinery. 10¼ by 8¼ in. St. Louis Well Machine & Tool Co., St. Louis.

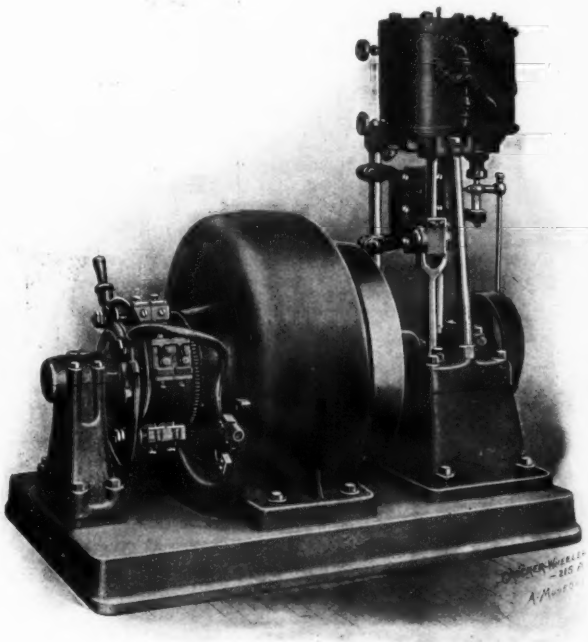
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A Small Engine-Generator Set.

THE demand for a small engine-generator set for marine purposes and use generally where compactness and low first cost are of more importance than low steam consumption and good fuel economy, has opened a most inviting field for just such an outfit as the one shown herewith. It is the outcome of an arrangement effected between the W. D. Forbes Company, of Hoboken, N. J., the builders of the engine, and the Crocker-Wheeler Company, of Ampère, N. J., whose standard open-type multipolar machine is used for the dynamo end of the unit. The set may be had in various sizes, but the particular one illustrated consists of a 7 by 6-inch simple engine capable of indicating 20 horse power under 100 pounds of steam when running at 425 revolutions per minute, and a four-pole, 20 D-type generator having a capacity of 8 kilowatts at that speed. Since illuminating is the class of service in which it will meet the most extended use, a more significant conception of its capacity may be conveyed in the statement that it is



FORBES-CROCKER-WHEELER ENGINE GENERATOR.

capable of lighting 140 sixteen-candle-power lamps. Nevertheless it is remarkable for its lightness and compactness, weighing but 2,800 pounds, and measuring in extreme dimensions but 52⅝ inches long, 35¼ inches wide and 51¾ inches high.

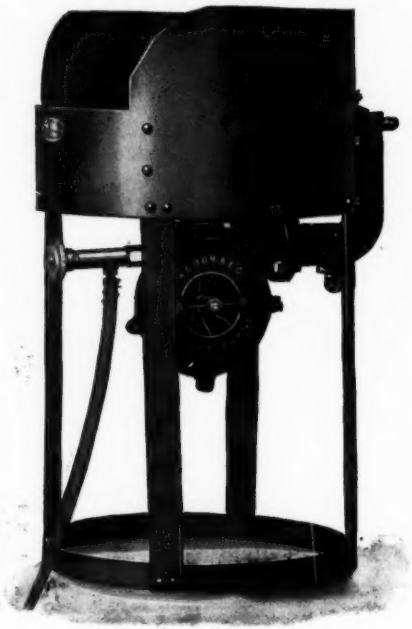
The engine by itself weighs only 475 pounds, this extremely light weight having been secured without sacrificing strength or rigidity, by employing scientifically correct lines in the design and the best grade of open-hearth steel for the forgings entering into its construction. The crank-shaft is machined from a solid forging, the cross-head and piston-rod are in one piece, and there were no welds permitted in any part. The outfit has been produced with special attention to the refinements essential to satisfactory operation. For example, speed regulation is provided by a "Rites" patent inertia governor, guaranteed to maintain within 2½ per cent. of constant speed, this being quite close enough to prevent the annoyance of flickering lights. Contrary to the usual custom, the governor is not combined with the fly-wheel, as a reference to the cut will show. This is of advantage, for while the best location of the fly-wheel is between the engine and generator, the governor should be where it is most accessible for adjusting. Although the cut does not show it, a gravity system of lubrication is furnished with the engine, whereby all moving parts are kept continuously oiled while the engine is running.

The generator is a compound-wound machine of the open type, there being not the slightest objection to its use in a case of this kind, as it may almost invariably be located where dust, moisture, combustible materials, or the usual conditions prevalent when an enclosed type of machine is demanded, do not exist. By virtue of its open construction, on the other hand, it possesses certain advantages not enjoyed by its semi-enclosed or fully-enclosed prototypes. Chief among these are the availability of all of its parts for inspection and repair, and the splendid ventilation afforded to the armature and windings, thus preventing excessive heating even under considerable overload.

The entire unit is the result of a most careful design, the component parts are of the highest class of material, and the set will be found capable of a steady and reliable service under long periods of continuous full load. Any further particulars will be gladly furnished by the Crocker-Wheeler Company, of Ampère, N. J.

The Chicago Air Forge

THE advantages of a light, portable forge, which can be put to a variety of uses, are apparent to all who have had practical experience with them, and where there is a supply of compressed air available, it forms a ready means for obtaining the necessary blast.



CHICAGO AIR FORGE.

The Chicago Pneumatic Tool Company manufacture several styles of portable forges which use oil fuel, but their latest type, the Chicago air forge, differs from the others in employing coal or coke.

The hose connection, through which the air enters this forge, is ¼-inch standard pipe connection; the air passing through a 1/16-inch needle valve jet forces the fan to revolve rapidly, and as the fan is open to the outer air, a blast of free air is con-

tinually blown through the tuyere. This method of using air to operate the fan, in addition to giving excellent results, effects a considerable saving in the amount of air consumed.

This machine uses either coal or coke, coke possibly giving the better results. It operates with an air pressure of from 60 to 100 pounds, and consumes approximately from 5 to 7 cubic feet of free air per minute. The fan revolves at approximately 4,000 revolutions per minute at 80 pounds pressure. It is 3 feet high over all, and the pan, or fire box, is of 20 inches diameter and 10 inches deep. The forge weighs 114 pounds complete.

This forge is without a doubt one of the most practical machines ever put on the market, and any further particulars regarding it will be gladly furnished by the Chicago Pneumatic Tool Co., of Chicago and New York.

The St. John Shaking Grate.

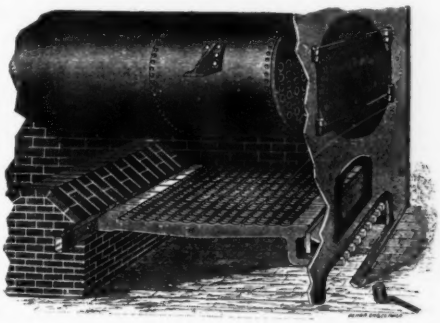
THE St. John grate bar, which is shown in the accompanying illustration, does not disturb the surface of the fire, but shakes the bottom evenly, carrying the clinker to the ash-pit as soon as possible, and so avoiding the unnecessary consumption of heat in fusing a large mass of clinker together.

No clinker is forced upward and into the surface of the fire, as the action of the bar is sidewise as well as vertical, and particles of clinker-forming material are compelled to drop out of the fire. The cutting effect is obtained by the side-cutting edges, as well as by the crest of the corrugations, and does not disturb the proper combustion of the fuel gases, as is done when a large amount of lift is given to the bars, and when a large surface of fire is disarranged at one operation.

These bars will burn a very large amount of coal per square foot of grate, owing to their large air space; and owing to their peculiar construction, on the truss principle, they are not at all liable to warp or twist, as their record shows. On account of the larger air space, the fire can draw as much air as is necessary for the proper combustion of the fuel, and as air is admitted under a very low velocity the heat is easily transferred from the gases to the water in the boiler, thus making this grate a most economical one for burning coal. The low velocity of the air will throw the control of the fire and the steam pressure more onto the damper regulator than heretofore, which means a much more regular pressure.

As clinker cannot fasten to these bars, it is not necessary to clean fires with prick bar and sledge hammer, nor with a stream of water. These grates save a great deal of labor, as the prick bar need not be used, slicing is reduced one-half or more, and the regular cleanings may be diminished at least one-third in number, or may be even omitted altogether.

The bars are shaken singly as far as possible, and alternately, the first, third, fifth and other odd bars being shaken first, and then the second, fourth, and other even bars. On account of the absence of clinker, this shaking is done easily at all times, and the fireman is very ready to use the shakers, as he knows that by proper attention he can avoid cleaning almost entirely.



ST. JOHN SHAKING GRATE.

By using the St. John shaking grate it is possible to burn a lower grade of fuel than heretofore, and as the fire door is kept closed more than in ordinary cases, the repair bills made necessary by the contraction of the shell, caused by the sudden influx of cold air striking the hot sheets, are much reduced.

Some of the advantages of this grate over other similar devices, may be summed up as follows: Simplicity of construction, which gives great durability, as a record of

fifteen years has shown; large air spaces, which give a thorough combustion of the fuel; and the very slight movement used, which disturbs the fire only at the point where the refuse is held, namely, at the bottom.

Any further information desired concerning the St. John grates and grate bars will be gladly furnished by Mr. A. B. Willoughby, selling agent, Machinery Department, Philadelphia Bourse, Philadelphia.

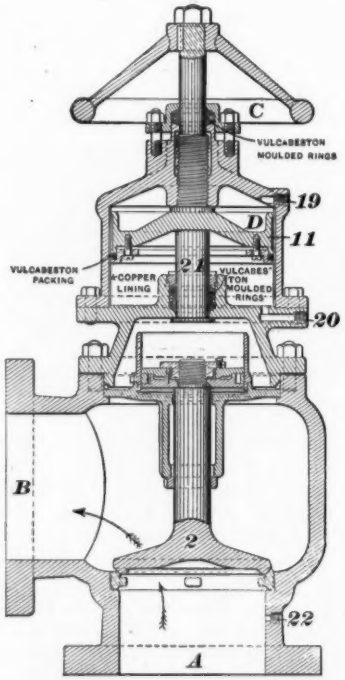
Automatic Stop Valve.

IT is of the highest importance in a steam plant, as well as with operating machinery of every kind, that it should run with the fewest possible accidental interruptions, and that when accidents do occur, that the damage occasioned by them should be reduced to a minimum. It is necessary, moreover, to provide safety devices which will effectually protect the attendants of machinery, and at the same time not interfere with its regular operation.

In a steam plant one of the dangers to be guarded against is the bursting of a pipe or a leak in a connection, which will flood the boiler room with live steam and cause injury or even death to the attendants unless the flow of steam can be cut off, and a great deal of ingenuity has been expended in providing valves which can be worked from a distance, or which will even close automatically in case of need. Such valves should also be adapted for use in the ordinary operation of the plant, if they are to be of the greatest service.

Among devices of this kind is the Foster combination valve, which can not only be closed by hand, either directly or from a distance, but will also shut off automatically.

The accompanying illustrations give a good idea of this valve, and a brief explanation of its action will be of interest: The full boiler pressure is always maintained by means of a pipe coming from the opening of the combination valve. The main line pressure is maintained on the diaphragm of a pilot valve, connection being made by a pipe to some distant point in the main line, where it will not cause lowering of the line pressure, should any outlet be quickly opened, and at the same time far enough from the boiler to permit of a sufficient fall of pressure to operate the pilot valve in case of breakage. A restricted nipple, fitted with a small strainer and union, is applied in this pipe a short distance from the main, and a stop valve interposed so that the nipple can be removed

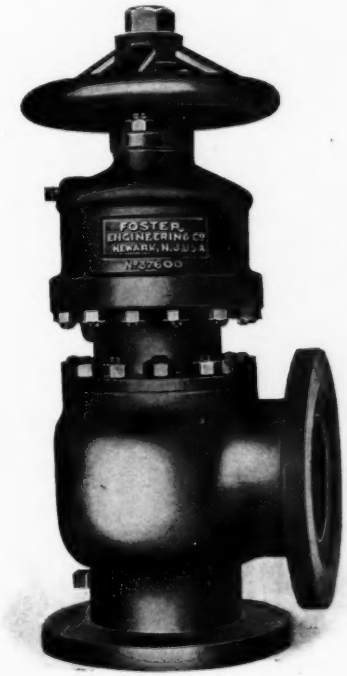


SECTIONAL VIEW OF THE FOSTER VALVE.

and the strainer cleaned. The spring of the pilot valve is set to keep it closed against a predetermined pressure, say within 50 pounds of actual or average working pressure. A sudden fall of pressure at the main will relieve the pressure in the chamber of the pilot, the spring immediately closing one valve and opening another, permitting the boiler steam to pass through the pilot valve and on through the pipe into the piston chamber of the combination valve. The pressure of this steam will act against the piston, which, being of greater area than the large valve, will instantly close the latter against its seat, and prevent the flow of steam in either direction.

The large valve will remain closed until pressure is again admitted to the main. The pilot valves should then be closed and opened respectively by means of a hand-wheel. The high-pressure steam in the chamber of the combination valve will then flow back through the pipe to the pilot, and out to the atmosphere. The drain pipe should have its opening in plain sight, at least one foot from the floor, or at the mouth of the funnel-shaped waste pipe.

The same construction is applicable to a plant having one or several boilers. In a battery of boilers the piping is arranged so that one pilot valve will operate two combination valves. Where a battery consists



FOSTER VALVE.

of a dozen or more boilers it is sometimes desirable to cut the batteries into sections, and run emergency pipes to some central point whence one or all sections can be operated instantly.

A somewhat different arrangement is required with combination valves for marine service, with which device, by the way, nearly all the United States torpedo boats and destroyers are equipped.

The Foster valve is not at all complicated, and anyone can easily understand its mechanism after reading the directions for its application and operation. Any further information desired will be gladly furnished by the Foster Engineering Co., of Newark, N. J.

The Kinkead Ore Mill.

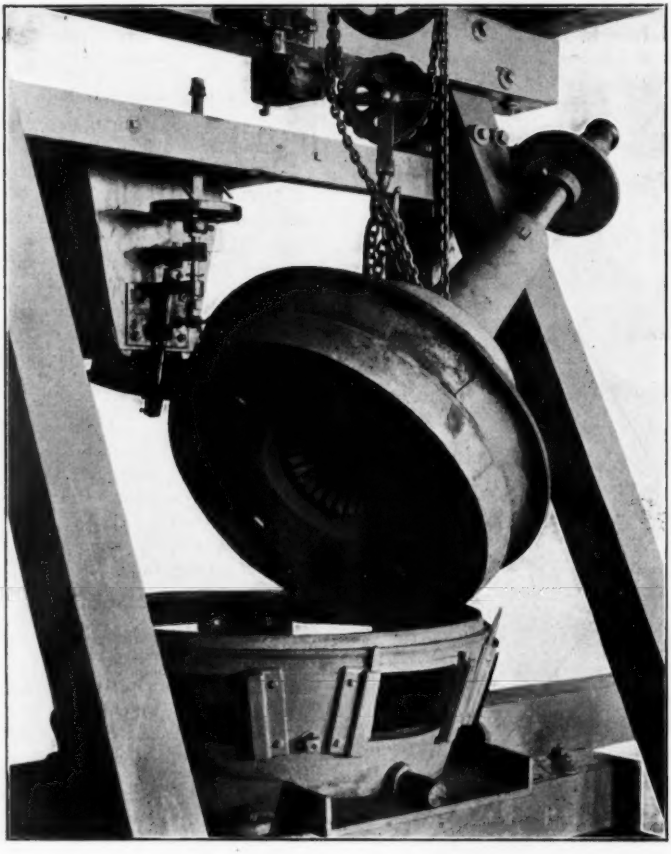
THE ordinary stamp mill, while it crushes ore rapidly and cheaply, on the whole, has some inherent defects which prevent it from being an economical device for getting the values out of ores. It pounds both the matrix and the metal into a conglomerate mass, and crushes a great deal of the ore too fine, forming flour gold and valuable slimes which are very difficult to save. Besides this, the stamp mill hammers the gold particles so hard that they become insensitive to amalgamation.

The Kinkead mill was devised to overcome the very defects that have just been mentioned, defects which are absolutely inseparable from a stamp mill. It consists of a pan four feet in diameter, containing a false convex steel bottom, known as the "die," and a heavy muller fitted with a steel "shoe" weighing about 3,000 pounds. By means of a very simple mechanism, shown in the illustration, a gyratory motion is given to this muller at the rate of about 150 revolutions per minute. The ore is automatically fed with water, not at fixed intervals, as is the case with some roller mills, but just as fast as the mill can grind it, and no faster. It enters the mill at the center of the muller, and the larger pieces are crushed there. The convex bottom of the pan and the water carry the pulp nearer to the edge of the pan where the fine crushing is done. As the thickness of the layer of ore increases, the muller rises, the friction discs do not engage and the feeder stops until the ore layer decreases in thickness sufficiently to bring the friction discs again into contact. Having reached the edge of the pan it is splashed through the screens or falls back, if still too coarse, for further crushing.

Among the advantages of this mill may be mentioned the following: It is "the mill that saves the values." No pounding or hammering can possibly occur. The muller rides gently upon a cushion of ore, and the ore is virtually crushed by the ore itself. Sliming and flouring are reduced to the lowest minimum possible. The free gold, instead of being hammered and rendered unfit for amalgamation, is scoured and put into a condition to be readily attacked by mercury.

The entire wear comes practically on the shoe and die, which are very nearly worn away before being replaced, and, moreover, the actual wear is only about a half pound per ton of hard quartz crushed to forty mesh. An immense saving is the result.

The capacity of the Kinkead mill is about ten tons of hard quartz per twenty-four hours through a forty-mesh screen, and about twice as much through a twenty-mesh screen, and proportionally more or less as the screen perforations increase or diminish in size. This is practically the capacity of a five-stamp battery.



KINKEAD MILL WITH MULLER TIPPED OVER.

Any further information which may be desired, will be gladly given by Henshaw, Bulkley & Co., sole agents, San Francisco